TO STUDY THE PREDICITIVE VALVE OF INTERNAL JUGULAR VEIN COLLAPSIBILITY INDEX AND COMMON CAROTID ARTERY PEAK SYSTOLIC VELOCITY VARIATION IN PREDICTION OF POST SPINAL HYPOTENSION

A THESIS SUBMITTED TO

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT (PUNJAB)

IN THE PARTIAL FULFILLMENT

FOR THE AWARD OF DEGREE OF

MD

IN

ANAESTHESIOLOGY

2024

Submitted By

DR PARTH ARORA

DEPARTMENT OF ANAESTHESIOLOGY
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA, PUNJAB

DECLARATION BY THE CANDIDATE

I hereby declare that the thesis entitled "**TO STUDY THE PREDICITIVE VALVE OF INTERNAL JUGULAR VEIN COLLAPSIBILITY INDEX AND COMMON CAROTID ARTERY PEAK SYSTOLIC VELOCITY VARIATION IN PREDICTION OF POST SPINAL HYPOTENSION**" submitted towards partial fulfillment of the requirements for the award of **MD in Anaesthesiology** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr. Suneet Kant Kathuria**, Professor, Department of Anaesthesiology, **Dr. Richa Jain**, Assoc. Professor, Department of Anaesthesiology. No part of this thesis has formed the basis for the award of any degree previously.

_____

Dr. PARTH ARORA
Department of Anaesthesiology,
Dayanand Medical College & Hospital,
Ludhiana, Punjab

Date:

Place:

CERTIFICATE OF SUPERVISORS

This is to certify that the work incorporated in this thesis entitled "**TO STUDY THE PREDICITIVE VALVE OF INTERNAL JUGULAR VEIN COLLAPSIBILITY INDEX AND COMMON CAROTID ARTERY PEAK SYSTOLIC VELOCITY VARIATION IN PREDICTION OF POST SPINAL HYPOTENSION**" has been carried out by **Dr. Parth Arora** under our direct supervision. The data incorporated in this thesis is original and genuine and has been carried out by the candidate himself.

Signature of Supervisor

Dr. Suneet Kant Kathuria
Professor
Department of Anaesthesiology
DMC&H, Ludhiana

Signature of Co-Supervisors

Dr. Richa Jain
Assoc. Professor
Department of Anaesthesiology
DMC&H, Ludhiana

Date:

ENDORSEMENT BY THE HEAD OF THE INSTITUTE

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Dr Parth Arora
Department of Anaesthesiology,
Dayanand Medical College & Hospital,
Ludhiana, Punjab - 141001

Date:

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DEDICATED TO MY PARENTS
Mr. RAKESH KUMAR
&
Mrs. SEEMA THAKRAL

Thank you for always believing in me, your unwavering support, blessings and encouragement have been cornerstone of my academic journey

ACKNOWLEDGEMENT

First and foremost, praises and thanks to God, the Almighty, for His showers of blessings throughout my research work to complete the research successfully

I would like to express my deep and sincere gratitude to my supervisor, Dr. Suneet Kant Kathuria, Professor & Head, Department of Anaesthesiology, Dayanand Medical College and Hospital, Ludhiana. He played a pivotal role in this study with his unerring accuracy and ability to solve problems amicably. The depth of his knowledge of Anaesthesiology never fails to impress and motivate me. He has been a constant source of encouragement, invaluable ideas and suggestions throughout this study. I whole heartedly express my sincere thanks and indebtedness for his pertinent guidance and constant support to complete my study successfully.

I owe a deep sense of gratitude to my co-supervisor, Dr. Richa Jain, Associate Professor, Department of Anaesthesiology, Dayanand Medical College and Hospital, Ludhiana for her invaluable suggestions at all stages of my study. Her warm encouragement and thoughtful guidance which encouraged me to complete the study successfully.

I would not have undertaken this journey without my parents Mr. Rakesh Kumar and Mrs. Seema Thakral, and my beloved partner Dr. Kaveri Joshi who taught me to be unique, to live with Dignity and encouraged me to work towards my dreams.

My words fall short today to express how grateful I am to have been blessed with the love, understanding, and support of my friends and colleagues Dr. Vipul Bansal, Dr Purnima Banot, Dr. Sameera Kohli, Dr. Shubham Longia, Dr. Sarvesh Chaudhary, Dr. Sanjamjot Singh, Dr. Jaskaran Singh, Dr. Abhinav Gupta, Dr. Sukhkamal Singh, Dr. Nishant Kamboj and Mr. Sumit Garg for always being there for me.

I express my thanks to all medical and paramedical staff, Dayanand Medical College and Hospital, for their ever-helping gesture and willingness to cooperate. I owe a deep sense of gratitude to all the patients who were a part of this study. I thank to Miss. Namita Bansal, Mr. Tarun Sharma, Mr Sushil and whole team of the Research and Development department, Dayanand Medical College and Hospital, Ludhiana for the immense help. Finally, I would like to pay my profound regards to the almighty, for the wisdom and perseverance that he has bestowed upon me during this study and indeed, throughout my life.

Parth Arora

ABBREVIATIONS

µg	Microgram
ASA	American Society of Anaesthesiologists
AUC	Area under curve
AUROC	Area under receiver operating characteristic curve
BMI	Body mass index
CAPVV	Carotid artery peak systolic flow velocity variation
CBF	Carotid blood flow
CCA	Common carotid artery
ccFT	Corrected carotid flow time
Cm	Centimetre
cm/s	Centimeter per second
CO	Cardiac output
CPSV	Carotid peak systolic velocity
CSA	Cross-sectional area
CVP	Central venous pressure monitoring
DBP	Diastolic blood pressure
FT_c	Corrected flow time
G	Gauge
HR	Heart rate
ICU	Intensive care unit
IJV	Internal jugular vein
IJV-A	Internal Jugular Vein area
IJVCCI	Internal jugular vein collapsibility index
IJV-D	Internal Jugular Vein diameter
IVC	Inferior vena cava
IVCCI	Inferior vena cava collapsibility index
Kg	Kilogram
Kg/m^2	Kilogram per square meter
LVOT	Left ventricular outflow tract
MAP	Mean arterial pressure
MBS	Modified Bromage Score

Ml	Millilitre
ml/kg	Milliliters per kilogram
NIBP	Non-invasive blood pressure
PI	Perfusion index
PLR	Passive leg raising
PLRT	Passive leg raising test
PP	Pulse pressure
PPV	Pulse pressure variation
PSAH	Post spinal anaesthesia hypotension
PSH	Post spinal hypotension
PV	Peak velocity
PVI	Plethysmographic variability index
ROC	Receiver operating characteristic
SAB	Subarachnoid block
SBP	Systolic blood pressure
SCV	Subclavian veins
SD	Standard deviation
SPO_2	Oxygen saturation
SROC	Summary receiver operating characteristic
SVC	Superior vena cava
SVR	Systemic vascular resistance
TEE	Transesophageal echocardiogram
TTE	Transthoracic echocardiography
VTI	Velocity time integral

ABSTRACT

Introduction: Hypotension after spinal anaesthesia is one of the commonest complications that occur due to sympatholysis. Intra-operative arterial hypotension has been linked to an increase in patient morbidity and mortality. In few studies the Internal Jugular Vein Collapsibility Index and Common Carotid Artery Peak Systolic Variations have shown to help in prediction of hypotension after spinal anaesthesia

Aim of the study: To study the predictive value of internal jugular vein collapsibility index and common carotid artery peak systolic velocity variation in prediction of post spinal hypotension

Materials & methods: A prospective observational study was conducted on 53 adult patients of ASA I, II and III scheduled to undergo elective surgery under spinal anaesthesia after obtaining a written informed consent. The internal jugular vein collapsibility index and common carotid artery peak systolic velocity variation were measured using ultrasonography for prediction of post spinal hypotension. After giving spinal anaesthesia using a standard protocol, heart rate, systolic, diastolic and mean blood pressure were monitored upto 30 minutes to compare incidence and severity of hypotension.

Results: Post spinal hypotension was found in 39.6% (21 out of 53) patients. The cutoff value of IJVCI calculated was 21.58% with sensitivity of 71.43% and specificity of 84.38% for predicting post spinal hypotension. The area under ROC curve for IJVCI was 0.769 ($p = 0.001$) with 79.25% accuracy. Whereas the cutoff value calculated for CAPVV was 12.16% with sensitivity 85.71% and specificity of 56.25% for predicting post spinal hypotension. With area under ROC curve for CAPVV as 0.760 (p value = 0.004) CAPVV had an 67.92% accuracy.

Conclusion: IJVCI assessment was found to have more specificity (84.38%), whereas CAPVV had more sensitivity (85.71%) for prediction of hypotension. Overall, in terms of accuracy IJVCI was found to be a better predictor of hypotension post spinal anaesthesia as compared to CAPVV assessment.

Keywords: Common Carotid Artery, Peak Systolic Velocity, Internal Jugular Vein Collapsibility Index, Spinal Anaesthesia, Hypotension, Post Spinal Hypotension

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INTRODUCTION

Spinal anaesthesia is a safe and reliable method frequently used in various lower abdominal, orthopedic, and obstetric operations. It has advantages such as the rapid onset of action, cost-effectiveness, ease of administration, and relatively fewer side effects

Subarachnoid block can be associated with side effects like nausea, vomiting, hypotension, bradycardia, cardiac arrhythmias, cardiac arrest, and sometimes even mortality.[1] Post Spinal Hypotension (PSH) is one of the commonest side effect, and its incidence ranges between 30-40%[2] Intraoperative hypotension is a manifestation of an imbalance in the body's regulation of the cardiocirculatory system. It occurs due to fall in the systemic vascular resistance (SVR) because of sympatholysis and decrease in cardiac output (CO) because of reduced venous return.[3] It can lead to tissue under-perfusion and consequent ischaemia of vital organs, which can cause ischemic stroke, myocardial injury, heart failure, acute kidney injury[4] Intraoperative hypotension has been found to correlate with poor post-operative outcome, prolonged hospital stay and an increase in morbidity and mortality.[5] The early prediction of post spinal hypotension is important to a successful outcome, as timely interventions may prevent any untoward event.

In clinical practice, a number of measures are being taken to prevent and treat hypotension due to spinal anaesthesia like intravenous (IV) fluid loading, wrapping lower limbs using compression stockings and using inotropes and vasopressors.[6] However, most of these have limited effectiveness, and are associated with several dangerous consequences especially in patients with hypovolemia, underlying cardiac and pulmonary diseases. Hence, accurate measurement of IV fluid volume status before giving spinal anaesthesia is of esteemed importance[7] IV fluid preloading and co-loading has shown to reduce the incidence of hypotension in patients of spinal anaesthesia.Various invasive and non-invasive methods have been employed to predict post spinal hypotension in patients like central venous pressure

monitoring (CVP), pulmonary artery catheter monitoring, jugular venous pressure monitoring, inferior vena cava collapsibility index (IVCCI), transthoracic echocardiography (TTE), transthoracic bioimpedance, passive leg raising test (PLRT) etc.[8,9]

CVP monitoring was earlier considered as a gold standard method for fluid status evaluation. According to current international guidelines, it is no longer acceptable to perform fluid resuscitation using CVP alone.[10] It is an invasive and time consuming intervention. Complications associated with central venous catheter insertion are, injury to local structures, air embolism, phlebitis at site of insertion, hematoma, thrombosis, infection and arrhythmias.[11]

Pulmonary artery catheter is a tool for the assessment of functional hemodynamic parameter such as fluid responsiveness.[12] It has comparatively high complication rates and invasiveness, which makes its widespread use controversial.

Transthoracic echocardiography is an essential tool for fluid assessment and resuscitation in critically ill patients. Methods like transthoracic echocardiography and bio-impedance are time consuming and expensive. Transesophageal echocardiogram (TEE) is another microinvasive monitoring device, however it can result in oral and oesophageal mucosal injury.[13]

Non-invasive methods like passive leg raising test have varied results[14] Passive leg raising (PLR) test has been useful in assessment of fluid responsiveness in patients of shock. Plethysmographic variability index (PVI) is a new, simple and non-invasive method for perfusion assessment. PVI derived from non-invasive pulse oximeter is a reliable indicator of fluid or preload responsiveness. However, inaccurate sensor positioning and motion artifacts can cause the PVI value to fluctuate.[15]

Ultrasonography is a non-invasive and real time tool for assessing the volume status of the patients, It helps in predicting the responsiveness of patients to fluid therapy. Sonographic evaluation of the main vessels at bedside provides a high degree of sensitivity and specificity in assessing intravascular volume status and response to fluid

administration. The ideal test to evaluate the patient's hemodynamic status should be inexpensive, simple to use, non-invasive, and able to provide clinically relevant information with minimal inter-operator variability.

Non-invasive methods using ultrasound like inferior vena cava collapsibility index (IVCCI), internal jugular vein collapsibility index (IJVCI) and carotid artery peak systolic flow velocity variation (CAPVV) are easy to perform, less time consuming and are readily available. The IVCCI, IJVCI and CAPVV are most commonly used parameters for assessing the volume status of critically ill patients and have been individually investigated as predictors of post spinal hypotension and hypotension after induction of general anaesthesia.[9,16]

Carotid artery corrected flow time (FTc) using doppler ultrasound provides a reliable diagnostic accuracy for prediction of fluid status. It was discovered that the carotid artery FTc was a good predictor of fluid responsiveness in patients on mechanical ventilation. There exist certain constraints when utilizing the FTc, as it is susceptible to variations in cardiac contractility or afterload variability in addition to preload.[17]

Measurements of the superior vena cava (SVC) diameter and variation have been carried out by transoesophageal echocardiography. Ultrasound SVC measurements have been identified as a predictive indicator of fluid status.[18] Though the diameter of the SVC and stroke volume have a strong correlation in prediction of fluid status, their use is limited as their value may vary because of various factors such as tidal volume, abdominal pressure, lung and chest compliance, and positive end-expiratory pressure.

The measurement of the IVC collapsibility index and the variation in IVC diameter with respiration provide a reliable, non-invasive way to determine fluid status. However, IVCCI measurements are sometimes not possible in some of patients because of obesity, excessive gas in bowel, or large amounts of intra-thoracic air. The IVCCI depends on intrathoracic and intraabdominal pressures, which can be affected by any pathophysiological cause like asthma ,respiratory infection.[19]

It is well established that volume and pressure changes in the intrathoracic systemic vein compartment can be reflected by extra-thoracic veins such as in Internal Jugular Vein (IJV)[20] Ultrasonography of IJV diameter has also been studied in numerous studies to evaluate hypovolemia after blood donation. IJV diameter changes can help in early prediction of hypovolemia.[21] Positional changes in the cross-sectional area and diameter of IJV provide information about the fluid status of the patient.

In order to measure the fluid status indirectly, many internal jugular vein (IJV) parameters are being used more frequently in place of IVC measurements. The internal jugular vein (IJV) is relatively easy to visualize because of its close proximity to the body surface in comparison to inferior vena cava (IVC).

In a study conducted by Okamura et al.[22] Ultrasonographic IJV measurements helped in prediction of hypotension after general anaesthesia induction. Research has demonstrated that the intravascular volume and fluid responsiveness can be estimated using the IJV parameters. The right IJV collapsibility index has shown a good predictive ability for responsiveness to fluid administration.[23]

A study in surgical intensive care unit reported that IJVCI with a cut off more than 36% with sensitivity of 78% and specificity of 85%, helped in prediction of hypovolemia and fluid responsiveness in the patients with sepsis. [24]

Research has suggested that carotid artery ultrasound measurements may be useful adjuncts to assess fluid status. Several studies have examined various carotid parameters like systolic flow time, carotid artery diameter, carotid artery velocity, and carotid blood flow (CBF) volume. Carotid peak systolic velocity variation with a 14% cutoff and 86% sensitivity is the most well defined and supported measure to assess fluid status.[25]

According to numerous studies, pulse pressure variation, or PPV, is a reliable indicator of the fluid responsiveness in patients receiving mechanical ventilation.[26] The predictability of CAPVV for the fluid responsiveness was reported to be superior to that of pulse pressure

variation (PPV).[27] A better cut-off value with the higher sensitivity and specificity was obtained using CAPVV.

A number of studies using non-invasive methods utilising ultrasound have been done for fluid assessment. IJV collapsibility index is a useful indicator to predict post spinal hypotension (PSH). Research has also shown CAPVV to be an independent predictor of PSH. Till date no study has been done to compare IJV collapsibility index and CCA peak systolic variation for predicting post spinal anaesthesia hypotension, hence we compared both to find out which parameter out of above two is better for predicting hypotension after spinal anaesthesia.

AIMS AND OBJECTIVES OF THE STUDY

To study the predictive value of internal jugular vein collapsibility index and common carotid artery peak systolic velocity variation in prediction of post spinal hypotension

REVIEW OF LITERATURE

Hypotension post spinal anaesthesia is common, and is one of the important cause of concern for anaesthesiologists, especially in high-risky patients for instance the elderly and those with underlying organ dysfunction. Hypotension occurs due to fall in systemic vascular resistance (SVR) because of sympatholysis and decrease in cardiac output (CO). The reduction in SVR is due to sympathetic blockade from T1 to L2 with subsequent arteriolar vasodilation, which contributes to intraoperative hypotension. A decrease in the venous vasomotor tone increases the pooling of blood in lower body and thus reduces the return of blood, hence reducing the CO.[3] A reduction in stroke volume is the main cause of hypotension in the elderly population.

Post spinal hypotension along with bradycardia can lead to episodes of vomiting, syncope, dizziness, aspiration, cardiac arrhythmias, cardiac arrest, and sometimes even mortality. Hence early prediction of hypotension post spinal anaesthesia is crucial to a successful outcome, as timely interventions may prevent any untoward event. Numerous invasive and non-invasive methods have been researched till date in order to evaluate the volume status of patients.

Frölich et al (2002) observed a substantial correlation with the patient's baseline heart rate and sympathetic tone. In obstetric patients, they discovered the significance of baseline heart rate in prediction of hypotension following spinal anaesthesia. According to the study, patients with higher baseline heart rates had more sympathetic tone and were more likely to experience a blood pressure drop following spinal anaesthesia as a result of sympatholysis.[28]

A study by Chamchad et al (2004) evaluated weather hypotension following spinal anaesthesia for caesarean delivery can be predicted using the point correlation dimension (PD2), a measure of heart rate variability. A total 22 study participants (aged 22– 40 year) were divided into two groups. LO group which developed hypotension post spinal anaesthesia and HI group with no case of hypotension. They found HI group had a mean baseline heart rate 81 bpm± 9.6 whereas

LO group patients had baseline heart rate 95 bpm±10.2. A higher baseline heart rate has been found to reflect a higher sympathetic tone in a person. As a result of spinal sympathetic blockade, individuals with higher sympathetic activity are more susceptible to hypotension. [29]

Fluid preloading is one of the effective methods to prevent hypotension after spinal anaesthesia. In a study Carvalho et al (2009) found out that pre-loading and co-loading with colloid were equally effective in prevention of post spinal anaesthesia hypotension for caesarean delivery.[30]

Sadati et al (2018) aimed to analyse the effect of wearing compression socks on degree of hypotension and ephedrine administration after spinal anaesthesia in 80 candidates for caesarean section equally divided into two groups (intervention and control). Candidates of intervention group wore compression socks. Hypotension was more common in the control group which was without compression socks. They showed that wearing compression socks is a non-invasive, effective and economical method for preventing post spinal anaesthesia hypotension, which also reduces the requirement for ephedrine administration.[31]

Monnet et al (2016) conducted a systematic review and meta-analysis of twenty-one studies investigating the passive leg raising (PLR) induced changes in cardiac output (CO) and in arterial pulse pressure (PP) in prediction of the fluid responsiveness in adults. For the PLR-induced changes in CO, the pooled sensitivity was 0.85 (0.81-0.88) and the pooled specificity was 0.91 (0.88-0.93).They concluded that changes in cardiac output due to passive leg raising is a reliable prediction marker of the fluid responsiveness in adults. [32]

Duggappa et al (2017) studied Perfusion index (PI) as a novel parameter for prediction of hypotension post spinal anaesthesia for the lower segment caesarean section. The ratio of pulsatile to non-pulsatile blood flow in peripheral vascular tissue is known as the perfusion index (PI), which is determined by a pulse oximeter by measuring the amount of infrared light that is absorbed. Parturients with the baseline PI >3.5 are at increased risk of development of hypotension following SAB.

Perfusion Index can be used as a tool for predicting hypotension in healthy parturients undergoing elective caesarean section under SAB.[33]

Kuwate et al (2018) conducted a study on fifty patients undergoing elective caesarean delivery for evaluating the effectiveness of plethysmography variability index (PVI) in prediction of hypotension post spinal anaesthesia. Hypotension occurred in 32 patients. The area under the receiver-operating characteristic curve was 0.751 (95% confidence interval [CI]: 0.597–0.904) for pleth-variability index before anaesthesia. The optimum value for the PVI to predict hypotension has been 18% with sensitivity: 78.1%, specificity: 83.3%. Thus, in patients undergoing caesarean delivery, the PVI has proven to be a reliable indicator. of hypotension post spinal anaesthesia.[34]

Study by Ozyurt et al (2022) on prediction of hypotension post spinal by measurement of PVI in sitting position. Based on the Receiver Operating Characteristic (ROC) curve analysis, the time point with the highest predictive value is when the patient is placed in a sitting position to administer spinal anaesthesia. According to ROC curve analysis, the PVI value of patients was a predictor of spinal anaesthesia-induced hypotension with AUC = 0.780, 95% C I 0.633–0.927 with a cut-off value of 20.5% (specificity: 70.4%, sensitivity: 76.5%). Hence pleth variability index in the sitting position before spinal anaesthesia is a useful tool for prediction of post spinal hypotension during caesarean section.[35]

Jakovljevic et al (2014) studied effectiveness of bioreactance value in prediction of hypotension. The bioreactance measures phase shift of an oscillating current in voltage when current traverses the thoracic cavity. Bioreactance can be used as a clinical tool to evaluate volume responsiveness in different clinical setting. Cardiac output is continuously estimated using electrodes and analysing the occurring signal variation with different modes.[36]

Eskesen et al (2015) conducted a systematic review including 51 studies in order to evaluate the value of CVP in the prediction of fluid status and responsiveness. They divided into groups as lower (8

mmHg), intermediate (8–12 mmHg) and higher (12 mmHg) baseline CVP. The area under the receiver operating curve was above 0.50 in the 8 mmHg CVP group in contrast to the 8–12 mmHg and above 12 mmHg CVP groups in which the lower 95 % CI crossed 0.50. Certain CVP values, both higher and lower, showed some positive predictive value for fluid responsiveness.[37]

In a study by Kim et al (2021), the carotid artery corrected flow time was found to be a reliable indicator of spinal anaesthesia induced hypotension in parturients with an area under the ROC curve of more than 0.9. Left ventricular preload mainly affects FTc and is associated with myocardial contractility and afterload. The corrected carotid flow time (ccFT) is derived from a pulsed-wave Doppler signal at the common carotid artery.[38,39]

In the study conducted by Singh et al (2019) no positive correlation was found the relationship between ultrasonographic IVC measurements and post-spinal hypotension in 40 pregnant women undergoing elective cesarean section under SAB. Area under ROC curve of IVCCI with wedge to predict post spinal hypotension was 0.46 with a cut-of value was 25.64 % with a sensitivity of 60.9% and specificity of 35.5%. The study concluded IVCCI as a poor predictor of post spinal hypotension. As it was conducted only on young pregnant patients, who received intravenous crystalloid boluses at the time of spinal anaesthesia and were on maintenance fluids and this can be considered as an important limitation for the statistical results.[40]

Salama et al (2019) performed multivariate logistic regression analysis to find out important predictors of post spinal hypotension and found that caval aorta index (maximum IVC diameter/maximum aortic diameter) was the most significant predictor. It showed that caval aorta index had a sensitivity of 96%, a specificity of 88%, and an accuracy of 95% to predict post spinal hypotension at a cut-off point less than 1.2. IVC collapsibility index had a sensitivity of 84%, a specificity of 77% and an accuracy of 84% at a cut-off point more than 44.7%[19]

Jassim et al (2019) performed a comparison study in ICU patients using ultrasound estimation of IJV collapsibility index with IVC

collapsibility index and invasively monitored central venous pressure (CVP). The study revealed a noteworthy correlation between the IJV collapsibility index and the invasively monitored CVP, as determined by the diameter and cross-sectional area (CSA) at both 0° and 30° positions. With a sensitivity and specificity range of 73%–82% in predicting CVP, the most appropriate cutoff value for the collapsibility index for IJV CSA at 0 degree was found to be >14.1. The optimal cutoff value for collapsibility index of internal jugular vein cross-sectional area at 30° was determined to be >19%, with a sensitivity and specificity of 73%–83% in accurately predicting a central venous pressure of ≤10 mmHg.[41]

Ni et al (2022) analyzed that the development of hypotension after spinal anesthesia might be related to increased IVC collapsibility. IVCCI measurement using ultrasound was a reliable predictor of hypotension after induction of spinal anesthesia. According to ROC curve analysis, the sensitivity of IVCCI was 83.9%, specificity was 76.3% and the positive predictive value was 84%. at a cut-off point of >42%. Fluid management using IVCCI predictability helps in reducing incidence of post spinal anaesthesia hypotension.[9]

Ibrahim et al (2022) performed a study in 67 patients of both genders admitted to the surgical intensive care units. The study focused on use of ultrasonography as the first-line method for the non-invasive bedside assessment of the central venous pressure and fluid status in the patients who were critically ill. The IJVCI was found to be on lower side in cases with CVP greater than 10 mmHg compared to cases where CVP was less than 10. There were no statistically significant differences in the age or sex distribution between cases with CVP ≤10 and cases with CVP >10 mmHg. When predicting CVP ≤ 10, the IJVCI at 0° had a cut off > 21.4% with sensitivity of 88.4%, specificity of 79.2%, and accuracy of 85.1%; when predicting CVP ≤ 10, the IJVCI at 30° had a cut off 20.7% with sensitivity of 90.7%, specificity of 83.3%, and accuracy of 88.1%.[42]

It was demonstrated in the study by Okamura et al (2019) that IJV area (IJV-A) in the trendelenburg position prior to the initiation of general

anaesthesia, as assessed by ultrasound, is a predictor of hypotension during induction. The AUC of IJV-A in the trendelenburg position was 0.595 and the cut of value was 1.475 cm2 with sensitivity of 75.7% and specificity of 44.4%[22]

Broilo et al (2015) analysed respiratory variations in the IVC diameter and the IJV diameter in 39 ventilated patients with hemodynamic instability. Ultrasound measurement of changes in IJV diameter can be used as a substitute for IVC distensibility index when determining the appropriateness of volume expansion in the mechanically ventilated patients.[43]

A prospective observational research was conducted by Kılıç et al (2020) on patients who underwent elective surgery under spinal anaesthesia in the supine position. Total of 47 ASA I and ASA II patients ranging in age from 18 to 65 were included in the study. The maximum and minimum diameters, maximum area, and the collapsibility index of IJV were measured sonographically. The diagnostic value of IJV collapsibility index in the prediction of post spinal hypotension was assessed using ROC curve analysis. At cut-off point of 22.6%, the AUC was 0.709 95% CI- 0.56 to 0.86, p=0.014. IJV-CI was able to predict post spinal hypotension with a sensitivity of 64% and a specificity of 63.6%. Hence the IJV collapsibility index can serve as an alternate predictor of post spinal hypotension.[44]

In a study involving 73 adult patients, Abdelhamid et al (2022) postulated that the IJV collapsibility index (IJVCI), rates of change in the IJV-D (IJV-diameter), and IJA-A (IJV-area), when measured in the trendelenburg and supine positions, would be useful for predicting post spinal hypotensionin the elderly population. The patients who experienced PSAH (Post Spinal Anaesthesia Hypotension) had significantly higher levels of IJVCI, ΔIJV-D, and ΔIJV-A. The IJV-CI and ΔIJV-D were the independent predictors for PSAH with a moderate predictive ability when their baseline values were >34.4 for the IJV-CI (95% CI- 0.578–0.802) and >0.11 for the ΔJV-D (95% CI-0.519-0.752) with AUROC of 0.69 and 0.67 respectively. [45]

Elbadry et al (2022) did a study in 55 pregnant female patients posted for caesarean section to evaluate the predictive power of the internal jugular vein collapsibility index (IJVCI) and inferior vena cava collapsibility index (IVCCI) for PSAH. Based on PSAH incidence, cases were divided into two groups: those with PSAH (26 cases) and those without PSAH (29 cases). The IJVCI was found to be higher in cases with PSAH than in cases without PSAH in this study. Using a 38.5% cut-off value, the IJVCI demonstrated 84.6% and 82.8% sensitivity and specificity in predicting PSAH.[46]

Kayhan et al (2020) included 40 patients in prospective study who underwent elective surgical procedure performed under general anesthesia. They investigated the accuracy of IJV ultrasonographic assessment as the predictor of hypotension post induction of anesthesia. The IJV was sonographically measured in both the supine and trendelenburg positions prior to the induction of anesthesia. The patients were then divided into groups based on whether they had hypotension or not. Postinduction hypotension occurred in 24 patients (60%). The IJVCI in the trendelenburg position had a cut-off point of 19.9% with 62% sensitivity and 62% specificity to predict the episode of hypotension post induction. With an area under curve of 0.704 it was found that collapsibility index in the trendelenburg position was a reliable indicator of postinduction hypotension.[47]

Pharanitharan N, Sinha M et al (2023) recruited 91 parturients with a singleton pregnancy who had an elective lower segment caesarean section. Using M-mode imaging, the maximum and minimum IJV diameters (mm) and IJVCI were measured before spinal anaesthesia. 45.5% (40 of the 91) patients experienced at least one hypotensive episode during surgery. Using a cut-off point of 29.5%, ROC curve analysis revealed that IJVCI had a sensitivity and specificity of 70% and 23%, respectively, for predicting PSH during spontaneous breathing. The study determined that in pregnant patients undergoing elective caesarean sections, IJV parameters, such as maximum diameter, minimum diameter, and IJVCI, cannot be used as accurate predictors of post-spinal hypotension.[48]

In patients undergoing pressure support ventilation, a study by Iizuka et al (2020) compared the usefulness of the inferior vena cava's (IVC) collapsibility with that of the internal jugular veins (IJVs) and subclavian veins (SCVs). Anteroposterior diameters of IVC, SCV, and IJV were measured, and fluid responsiveness was accessed in 27 patients. For the right IJV antero-posterior diameter collapsibility, the AUROC curve was 0.88 cm2 with 95% confidence interval. According to the study, in patients on pressure support ventilation, the right IJV's collapsibility is a helpful indicator of their fluid responsiveness.[23]

Beier et al (2020) carried out a thorough analysis of efficacy of carotid ultrasonography measurements in assessing adult volume responsiveness with 956 patients. With areas under the receiver operating characteristic curves ranging from 0.81 to 0.91, sensitivities from 73% to 86%, and specificities from 78% to 86%, the ideal cutoff values for carotid artery peak velocity variations were found to be between 9.1% and 14%. [25]

Song et al (2014) found doppler evaluation of respirophasic carotid artery peak velocity variation (CAPVV) appeared to be a very practical and accurate technique for prediction of fluid responsiveness in the patients undergoing coronary revascularization who are on mechanical ventilation. For CAPVV, the ideal cut-off values for fluid responsiveness were 11% with sensitivity of 0.85 and the specificity of 0.82. CAPVV exhibited a higher predictive power compared to both radial arterial PPV and conventional static indices. [27]

Hossein-Nejad et al (2016) investigated the accuracy of IJV/CCA cross-sectional area (CSA) ratio in prediction of CVP in 52 critically ill adult patients. A noteworthy association was discovered between the CVP and the IJV/CCA CSA ratio; while the highest sensitivity was 90% the specificity was 86.36% for CVP of < 10 cmH2O. In order to assess the hemodynamic status of critically ill patients, a non-invasive alternative to central venous catheterization may be the IJV/CCA ratio using a portable sonographic device.[49]

The study by Bano et al (2018) showed that ultrasonographic IJV/CCA ratio could be an alternative and non-invasive tool of central venous

catheterization in evaluation of hemodynamic status of critically ill patients, in prediction of hypotension. With a cut-off value less than 1.75, the evaluation of volume status using a sonographic device and the IJV/CCA diameter ratio may be a helpful non-invasive substitute for a central venous catheterization.[8]

Chowdhury et al (2022) studied fifty patients age between eighteen to sixty-five, having elective lower abdominal surgeries performed under spinal anaesthesia. Using ultrasonography, the IVCCI and CAPVV were measured before surgery. The main aim was to evaluate and compare the role of IVCCI and CAPVV in prediction of PSH. With 70.6% sensitivity, 54.6% specificity, and an AUROC of 0.639, CAPVV >18.33 predicted PSH. They found out that CAPVV has low diagnostic accuracy when predicting PSH.[50]

Roy et al (2023) studied to evaluate the variation in carotid peak systolic velocity among fluid-responsive patients The average LVOT (Left ventricular outflow tract) VTI (velocity time integral) variation and the carotid peak systolic velocity (CPSV) variation have been correlated in this study. The study discovered that patients who respond well to fluid had a significant reduction in carotid peak systolic variation after fluid administration, which is similar to a decrease in stroke volume variation in fluid responsive patients. CPSV variation can be used in place of LVOT VTI as a surrogate marker of stroke volume variation in assessing fluid responsiveness.[51]

Singla et al (2023) conducted this systematic review and meta-analysis to evaluate the predictive accuracy of CAPVV and carotid corrected flow time in relation to fluid responsiveness. CAPVV had a pooled sensitivity and specificity of 0.83 and 0.81, correspondingly. The (SROC) summary receiver operating characteristic curve for CAPVV had an AUC of 0.8941. According to this research, CAPVV is a reliable indicator of fluid responsiveness. [52]

In above mentioned studies we have found non-invasive measurements to be useful in prediction of hypotension post spinal anaesthesia, so we compared two different indices of IJV collapsibility index and CCA peak systolic variation in prediction of hypotension.

MATERIAL AND METHODS

SOURCE OF DATA

This prospective, observational study was conducted in the Department of Anaesthesiology, Dayanand Medical College & Hospital, Ludhiana after approval by Institutional Ethics Committee on a total of 53 adult ASA physical status I, II and III patients undergoing surgery under spinal anaesthesia. A written informed consent was obtained from all the patients.

METHODS OF COLLECTION OF DATA

INCLUSION CRITERIA

- Patients Age > 18 Years
- Patients posted for elective surgery under spinal anaesthesia
- ASA I, II & III patients

EXCLUSION CRITERIA

- Patients' refusal to participate in the study
- Presence of any wound/dressing/swelling/structural abnormality in neck
- Infection at the site of spinal injection
- Thrombocytopenia and coagulopathies and patients on current anti-coagulant/anti-platelet therapy
- Pregnant females
- Pre-existing severe cardiac, renal or liver disease

PRE-ANAESTHETIC CHECKUP

A complete pre anaesthetic check-up was done which included a detailed history including allergy to any drug, pre-existing co-morbidities and medication history, general, physical and systemic examination and relevant laboratory investigations as per patient physical status and institutional protocol. The demographic details including age, gender, height, weight and body mass index (BMI) etc. were be recorded. Patient was explained about the study protocol and a written informed consent was obtained.

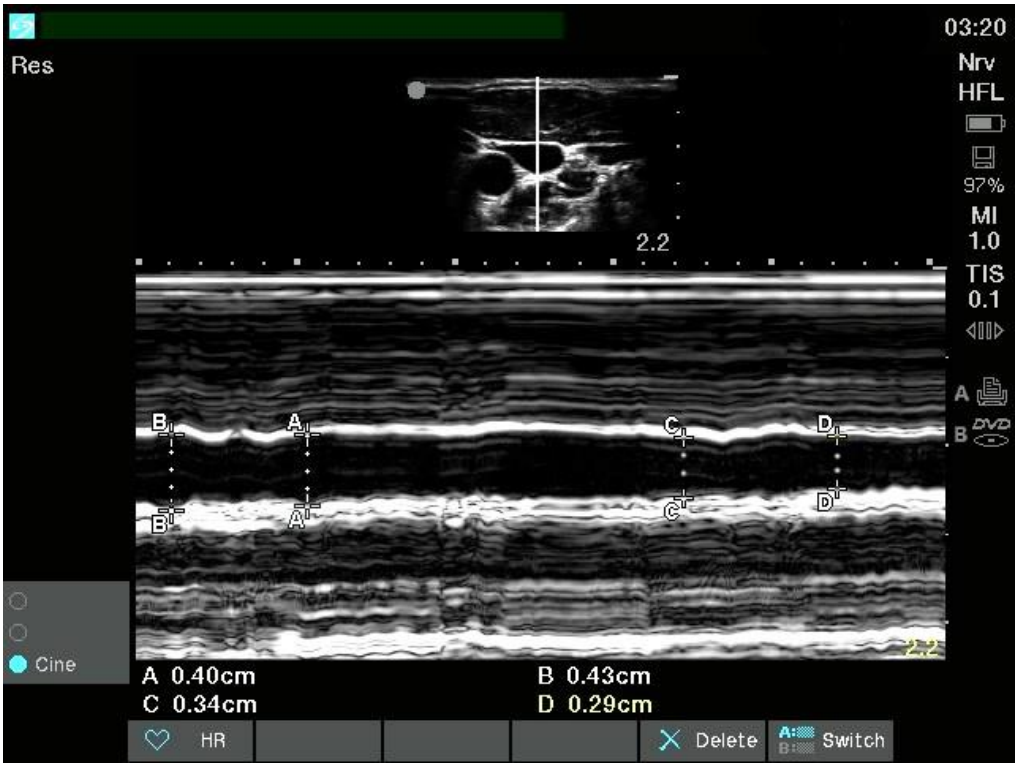
METHODOLOGY

After shifting the patient to operating room, patient was positioned in supine position. After sign in proceedings as per WHO protocol, standard monitoring was started using non-invasive blood pressure (NIBP), pulse oximetry and 5 lead electrocardiography. The baseline values of heart rate, NIBP, oxygen saturation, pulse rate were recorded after taking a mean of two successive readings at 2 minutes apart.

For IJV collapsibility index measurement, patient was positioned supine on the operating table with neck turned to the left side and head end elevated to 30°. The observer stood at the head end of the patient while the ultrasound machine (FUJIFILM SONOSITE EDGE II) was placed facing the observer. A high frequency (6 -13 MHz) linear ultrasound probe was then placed horizontally to the right-hand side of middle of the thyroid cartilage. Initially a clear, circular cross-sectional image of the right IJV was obtained by rotating the probe clockwise or counter-clockwise with minimal pressure on IJV. Then with use of M-mode of ultrasound, maximum and the minimum Antero-Posterior (AP) diameters of IJV were measured. IJV collapsibility index was derived by the formula:

IJV Collapsibility Index (IJV CI) =

(Maximum AP diameter - Minimum AP diameter)/ Max AP diameter X 100

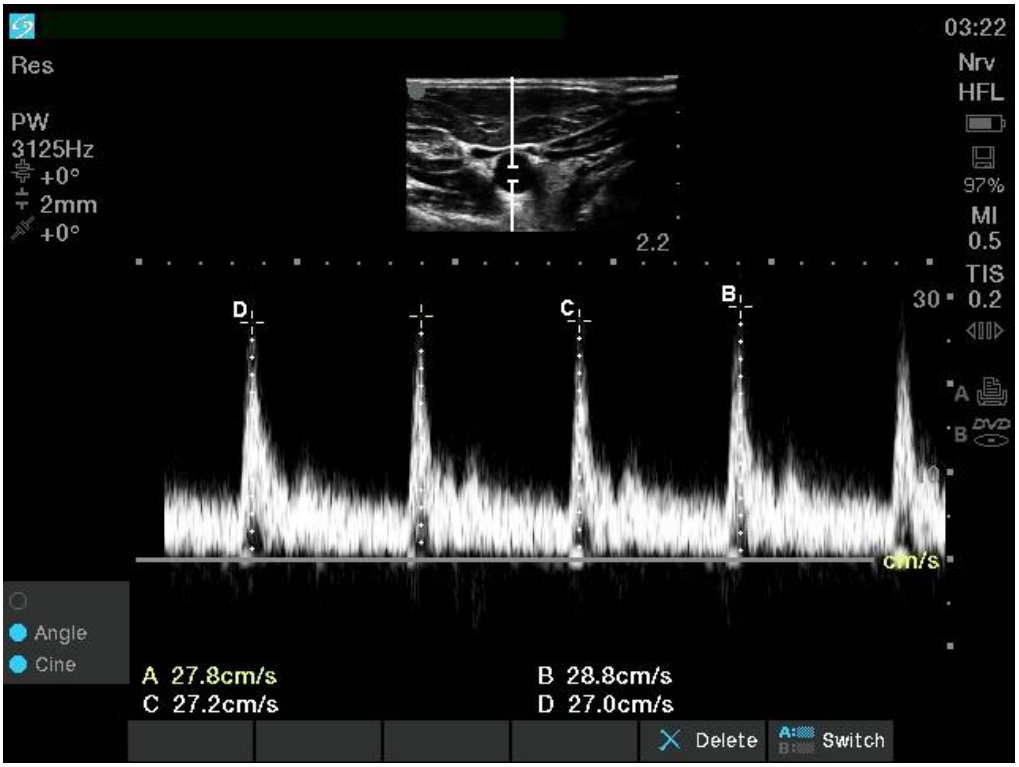


Picture 1: Ultrasound picture of IJV in M mode

For carotid artery peak systolic velocity (CAPSV) measurements, patient was kept in supine position with neck turned to the left side. The observer stood at the head end of the patient and the same ultrasound machine was placed facing the observer. The right carotid artery measurements were obtained at 2 centimeters proximal from carotid artery bifurcation using high frequency (6 -13 MHz) linear ultrasound probe. In long axis view, B-mode wave doppler was used to obtain waveforms of CCA at 60° insonation angle. The maximum peak systolic velocity (PV max) and minimum (PV min) peak systolic velocities were measured from the spectral doppler tracing with a sweep speed of 50 mm/s. Two readings of PV max and PV min were recorded and their mean was calculated. Carotid artery peak systolic velocity variation was calculated as:

Carotid Artery Peak Systolic Velocity Variation (CAPVV) =
[(PV max- PV min)/PV mean] × 100

where PV mean = (PV max + PV min)/2



Picture 2: Ultrasound picture of CCA in B- Mode wave doppler

Two readings of IJV CI and CA PVV were obtained and their mean values were calculated and recorded.

An appropriate size IV cannula was secured in a suitable peripheral vein and co-loading with crystalloid solution (10ml/kg over 15 minutes) was initiated while starting with induction of spinal anaesthesia.

With patient in sitting position, back of the patient was cleaned and draped using povidine iodine 10% w/v and subarachnoid block (SAB). was performed using 26 G Quincke needle in L_3 - L_4 inter spinal space. After confirmation of a free flow of CSF, 12.5mg Bupivacaine Heavy 0.5% (2.5ml) with 25 µg Fentanyl (0.5 ml) as an adjuvant, was injected in sub arachnoid space.

Patient was shifted to supine position immediately on a flat operating table. Patient's heart rate (HR), non-invasive blood pressure (NIBP) and oxygen saturation (SPO_2) were monitored and recorded immediately post spinal anaesthesia (zero minute) and then after every 2 minutes for first 30 minutes, as per standard protocol by the attending anaesthesiologist. The level of sensory block was assessed by loss of

pinprick sensation and level of the motor block was evaluated using Modified Bromage Scale (MBS) every 5 minutes till 30 minutes. The highest level / degree of sensory and the motor block achieved were recorded.

Modified Bromage Scale

0= free movement of legs and feet

1= unable to raise the extended legs but able to flex knees with free movement of feet

2= unable to flex knees but with the free movement of feet

3= unable to move legs and feet

Surgical procedure was permitted when the required level of sensory and the motor blockade was attained. Post spinal hypotension was defined as a reduction of the systolic blood pressure more than or equal to 20% of the baseline value after spinal anaesthesia.[53] The post spinal hypotension was treated with rapid iv fluid administration and intermittent boluses of ephedrine 6mg as per need. Bradycardia was described as heart rate going below 60 beats per minute and was managed with IV administration of 0.6mg atropine. Oxygen supplementation was given when the saturation fell below <94% or patient develops significant bradycardia or hypotension.

PRIMARY OUTCOME:

To study the predictive value of internal jugular vein collapsibility index and common carotid artery peak systolic velocity variation in prediction of post spinal hypotension.

SECONDARY OUTCOME:

To compare internal jugular vein collapsibility index and common carotid artery peak systolic velocity variation for prediction of severity of hypotension.

STATISTICAL ANALYSIS

The continuous variables like age, height, weight, BMI, HR, SBP, DBP, MAP, SPO2 were described in the terms of mean ±standard deviation (± SD), median (IQR)

The categorical variables like gender, ASA grade, MBS were described in the terms of frequencies (number of cases) and relative frequencies (percentages) as appropriate.

To determine whether the data were normally distributed, a Kolmogorov-Smirnov test was used.

Comparison of quantitative variables between the study groups like age, height, weight, BMI, carotid peak velocity, carotid artery peak velocity variation, IJV diameter, IJV collapsibility index was done using *Z* test for independent samples for non-parametric data.

For comparing categorical data, gender, ASA grade, MBS, highest level of sensory blockade achieved, highest degree of motor blockade achieved Chi square ($\chi 2$) test was performed.

Receiver operator characteristics (ROC) curve was done, and criterion value was estimated depending on the specificity and sensitivity. Area under curve (AUC) was measured.

Spearman rho correlation was also used. A probability value (*p* value) less than 0.05 was considered statistically significant.

All statistical calculations were done using (Statistical Package for the Social Science) SPSS 21.0 version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

Study Design - Prospective Observational Study

Sample Size Calculation:

Sample size calculation for this study was done by the following formula:

Sample size based on sensitivity = $Z^2 * S_N * (1-S_N)/L*p$

Sample size based on specificity = $Z^2 * S_P * (1-S_P)/L^2 * (1-p)$

Where S_N-Sensitivity, S_P- Specificity

p- Prevalence of Hypotension

L- Absolute precision desired on either side of sensitivity and specificity

Z- Standard normal deviate corresponding to the specified size of critical region

The sample size of 48 was estimated considering the sensitivity of 64% and specificity of 63.6% of IJV collapsibility index in predicting PSH as found in previous studies.[44]

The sample size of 47 was estimated considering the sensitivity of 70.6% and specificity of 54.6% of CCA peak flow velocity variation in predicting PSH as found in previous studies.[50]

Therefore, for our study considering the power analysis to achieve power of 80%, the higher value that was 48 cases had been taken. Hence the total sample size taken was 53 considering 10% dropouts.

OBSERVATION AND RESULTS

This prospective, observational study was conducted in Department of Anesthesiology, Dayanand Medical College & Hospital, Ludhiana on total of 53 adult patients above 18 years of age undergoing spinal anaesthesia for an elective surgery. The aim was to study the predictive value of internal jugular vein collapsibility index and common carotid artery peak systolic velocity variation in prediction of post spinal hypotension (PSH).

DEMOGRAPHIC PROFILE

Table 1: Gender distribution of patients

Gender	No. of cases	Percentage
F	12	22.6%
M	41	77.4%
Total	53	100.0%

The study was conducted on the patients of both genders with ASA grading of I, II and III. However, there were 41 males (77.4%) and 12 females (22.6%). The demographic profile of the patients is as under:

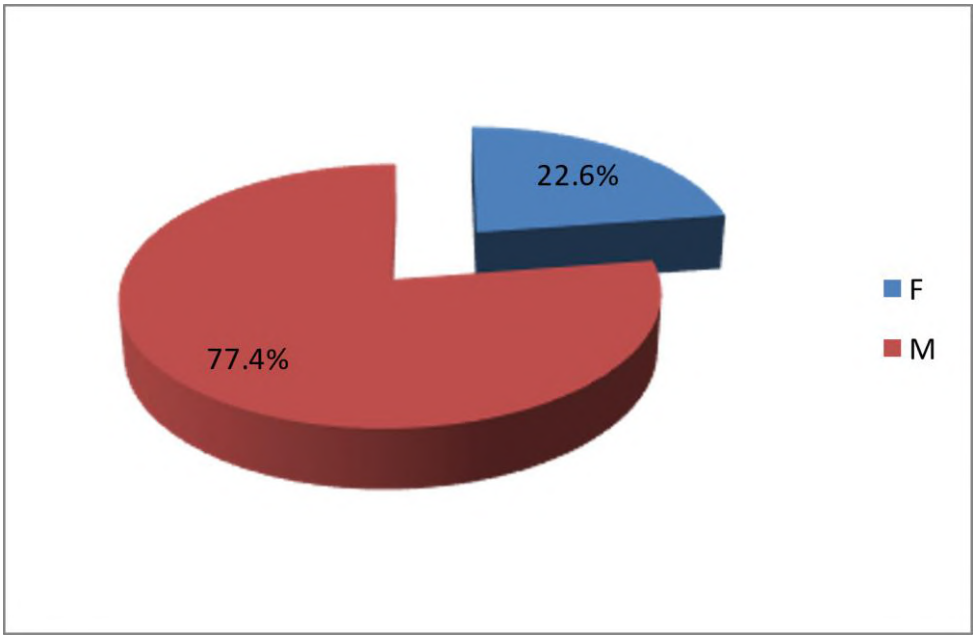


Figure 1: Gender distribution of patients

Table 2: Age, weight, height and BMI of all the patients

	N	Minimum	Maximum	Mean	Std. Deviation
Age	53	18.00	76.00	43.57	14.78
Weight (Kg)	53	42.00	121.00	76.02	17.88
Height (cm)	53	152	191	169.64	8.21
BMI (Kg/m^2)	53	18.18	36.13	26.18	4.63

No significant difference was seen with respect to age, weight, height and body mass index (BMI) of the patients. Mean age of the patients was 43.57± 14.78, mean weight was 76.02± 17.88, mean height was 169.64± 8.21 and mean BMI was 26.18± 4.63

Table 3: ASA grade of patients

ASA Grade	No. of cases	Percentage
I	21	39.6%
II	26	49.1%
III	6	11.3%
Total	53	100.0%

Among 53 patients, 21 patients (39.6%) were of ASA I grade, 26 patients (49.1%) were of ASA II grade and remaining 6 patients (11.3%) were of ASA III grade

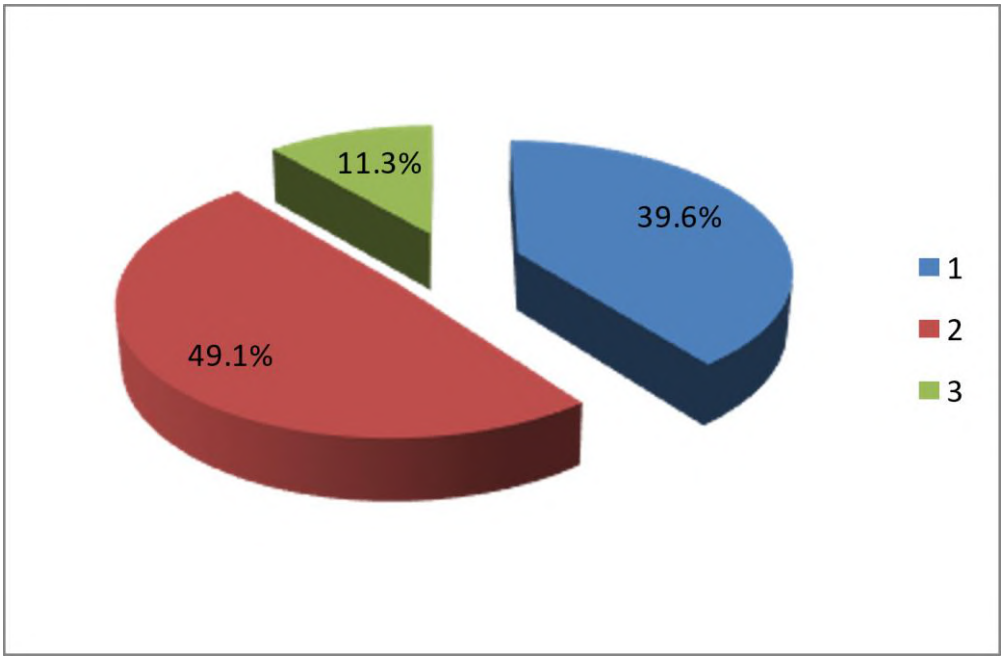


Figure 2: ASA grade of patients

Table 4 IJV parameters of all patients

	N	Minimum	Maximum	Mean	Std. Deviation
IJV _Maximum diameter (cm)	53	0.35	1.59	0.92	0.31
IJV _Minimum diameter (cm)	53	0.19	1.47	0.75	0.29
IJV Collapsibility index %	53	4.54	47.18	19.59	9.02

The IJV maximum diameter was 0.92± (0.31) cm and the minimum IJV diameter was 0.75± (0.29) cm, measured using ultrasound before applying spinal anaesthesia in all patients. IJV collapsibility index was 19.59± (9.02) % calculated after measuring the above diameters.

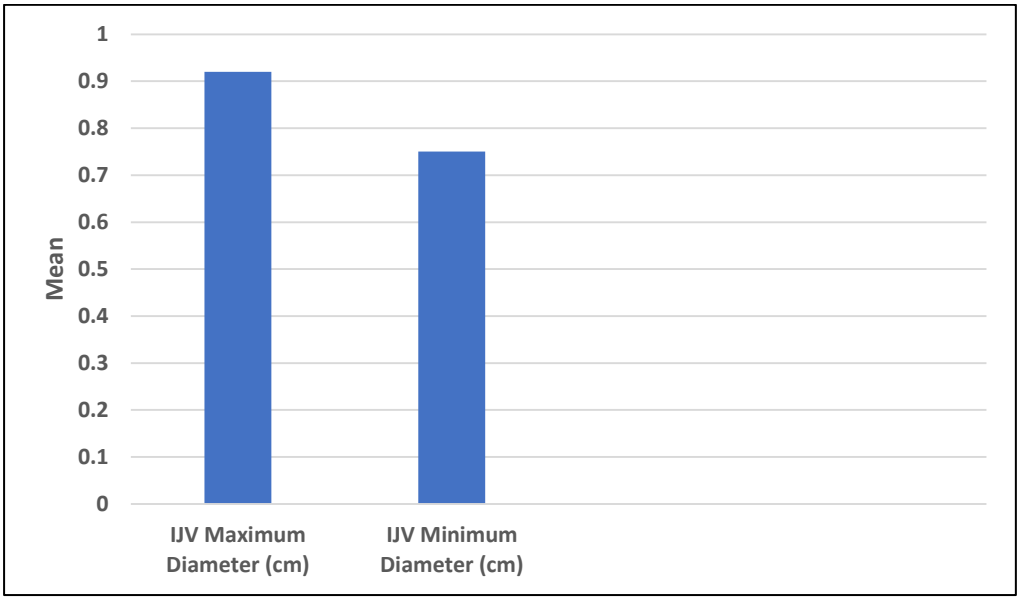


Figure 3: IJV diameter of all patients

Table 5: CCA parameters of all the patients

	N	Minimum	Maximum	Mean	Std. Deviation
Maximum Carotid Peak velocity (cm/s)	53	10.07	29.85	18.37	5.15
Minimum Carotid Peak velocity (cm/s)	53	8.49	27.30	15.94	4.80
Mean Carotid Peak Velocity (cm/s)	53	9.28	28.57	17.17	4.93
Carotid Artery Peak Systolic Velocity Variation%	53	3.05	41	14.54	6.91

The maximum carotid peak velocity was 18.37 ±(5.15) cm/s, the minimum carotid peak velocity was 15.94 ±(4.80) (cm/s) and the mean carotid peak velocity was 17.17 ±(4.93) (cm/s) measured using ultrasound before applying spinal anaesthesia in all patients. The carotid artery peak systolic velocity variation index was 14.54±(6.91) calculated after measuring above given velocities.

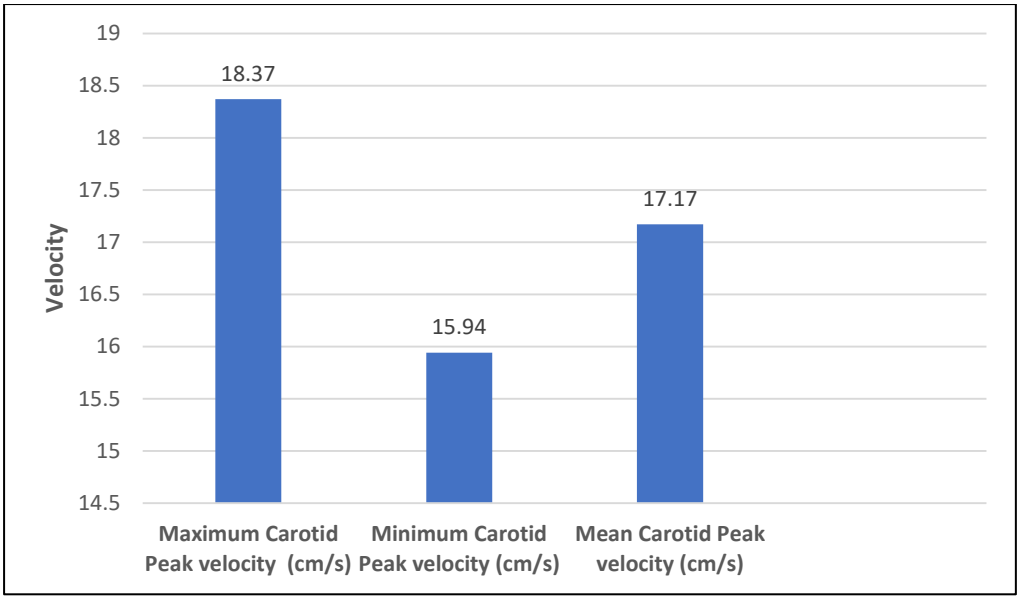


Figure 4: Carotid peak velocity of all the patients

Table 6: Intra-operative heart rate of all patients

	N	Mean	SD	Minimum	Maximum
	Valid				
HR_ Baseline	53	87.17	14.42	64.00	132.00
HR_0 Minute	53	87.94	15.09	62.00	132.00
HR_2 Minute	53	86.70	14.80	63.00	130.00
HR_4 Minute	53	85.77	15.30	62.00	128.00
HR_6 Minute	53	84.89	14.58	64.00	124.00
HR_8 Minute	53	83.30	14.51	64.00	122.00
HR_10 Minute	53	82.64	14.61	60.00	120.00
HR_12 Minute	53	81.58	14.50	61.00	116.00
HR_14 Minute	53	80.53	14.95	62.00	120.00
HR_16 Minute	53	80.30	14.73	62.00	124.00
HR_18 Minute	53	79.64	14.43	62.00	118.00
HR_20 Minute	53	79.45	13.45	60.00	114.00
HR_22 Minute	53	79.87	13.41	61.00	110.00
HR_24 Minute	53	79.68	12.83	64.00	112.00
HR_26 Minute	53	79.89	13.19	63.00	114.00
HR_28 Minute	53	80.40	13.43	62.00	116.00
HR_30 Minute	53	80.51	13.24	63.00	118.00
HR_40 Minute	53	80.51	13.67	62.00	120.00
HR_50 Minute	53	80.89	14.18	60.00	122.00
HR_60 Minute	53	81.08	13.58	62.00	124.00

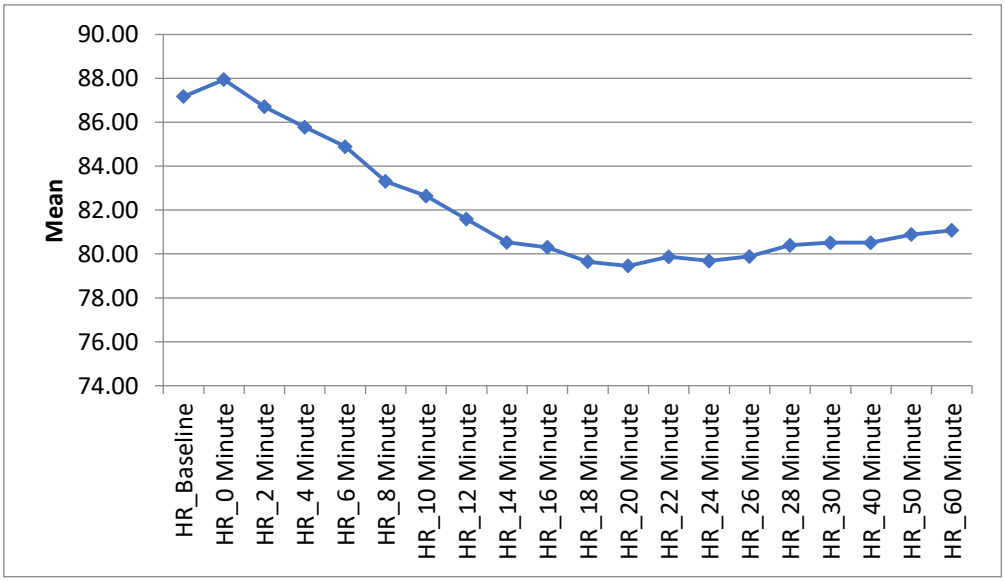


Figure 5: Intra-operative heart rate of all patients

Table 7: Intra-operative systolic blood pressure of all patients

	N	Mean	SD	Minimum	Maximum
	Valid				
SBP_ Baseline	53	140.23	16.71	115.00	195.00
SBP_0 Minute	53	140.49	16.54	116.00	200.00
SBP_2 Minute	53	140.83	32.82	114.00	346.00
SBP_4 Minute	53	133.00	15.65	111.00	184.00
SBP_6 Minute	53	129.83	15.33	110.00	170.00
SBP_8 Minute	53	126.30	14.01	101.00	164.00
SBP_10 Minute	53	122.32	13.35	102.00	155.00
SBP_12 Minute	53	119.57	13.29	94.00	160.00
SBP_14 Minute	53	117.17	12.95	96.00	152.00
SBP_16 Minute	53	114.04	19.30	10.00	154.00
SBP_18 Minute	53	116.11	12.21	92.00	152.00
SBP_20 Minute	53	117.21	12.48	90.00	150.00
SBP_22 Minute	53	118.42	11.31	98.00	152.00
SBP_24 Minute	53	119.25	10.63	102.00	150.00
SBP_26 Minute	53	120.02	10.57	100.00	148.00
SBP_28 Minute	53	121.17	10.54	102.00	150.00
SBP_30 Minute	53	122.74	9.63	106.00	151.00
SBP_40 Minute	53	123.79	9.93	106.00	152.00
SBP_50 Minute	53	124.34	10.11	108.00	154.00
SBP_60 Minute	53	125.53	9.70	109.00	156.00

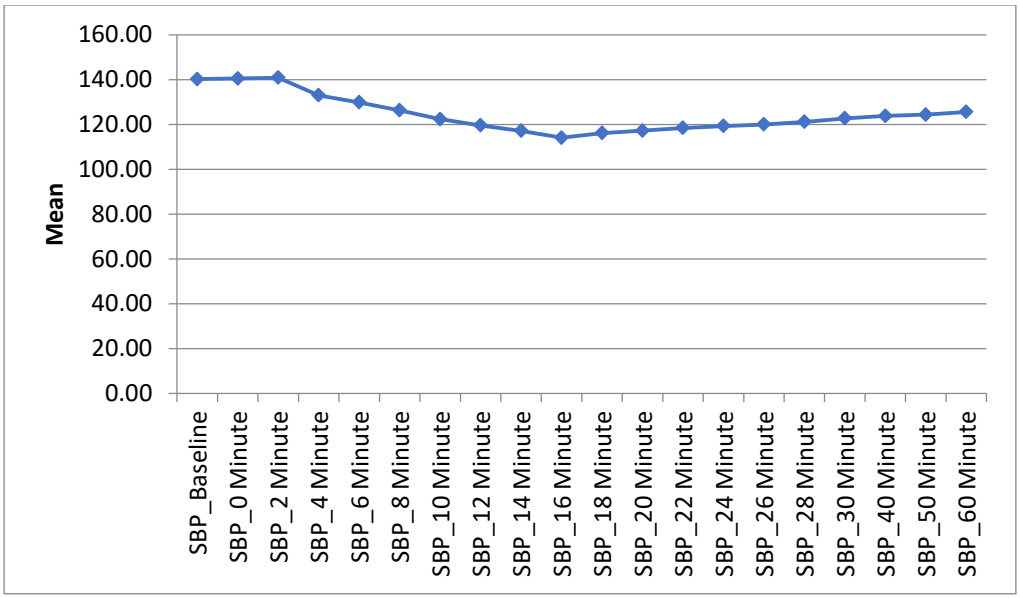


Figure 6: Intra-operative systolic blood pressure of all patients

Table 8: Intra-operative diastolic blood pressure of all patients

	N	Mean	SD	Minimum	Maximum
	Valid				
DBP_ Baseline	53	85.58	12.29	61.00	129.00
DBP_0 Minute	53	85.09	10.91	62.00	128.00
DBP_2 Minute	53	83.13	10.46	60.00	120.00
DBP_4 Minute	53	80.06	10.45	58.00	116.00
DBP_6 Minute	53	77.89	9.89	59.00	108.00
DBP_8 Minute	53	75.83	10.18	48.00	106.00
DBP_10 Minute	53	74.55	9.86	52.00	102.00
DBP_12 Minute	53	72.66	9.74	50.00	102.00
DBP_14 Minute	53	70.85	9.66	40.00	98.00
DBP_16 Minute	53	69.98	9.64	42.00	98.00
DBP_18 Minute	53	70.13	9.15	46.00	94.00
DBP_20 Minute	53	70.64	9.42	48.00	92.00
DBP_22 Minute	53	71.66	8.42	50.00	92.00
DBP_24 Minute	53	71.89	7.97	52.00	90.00
DBP_26 Minute	53	72.34	7.81	52.00	92.00
DBP_28 Minute	53	72.94	7.73	54.00	92.00
DBP_30 Minute	53	73.87	8.19	52.00	90.00
DBP_40 Minute	53	74.72	7.69	58.00	90.00
DBP_50 Minute	53	75.13	7.66	56.00	90.00
DBP_60 Minute	53	76.38	7.80	56.00	96.00

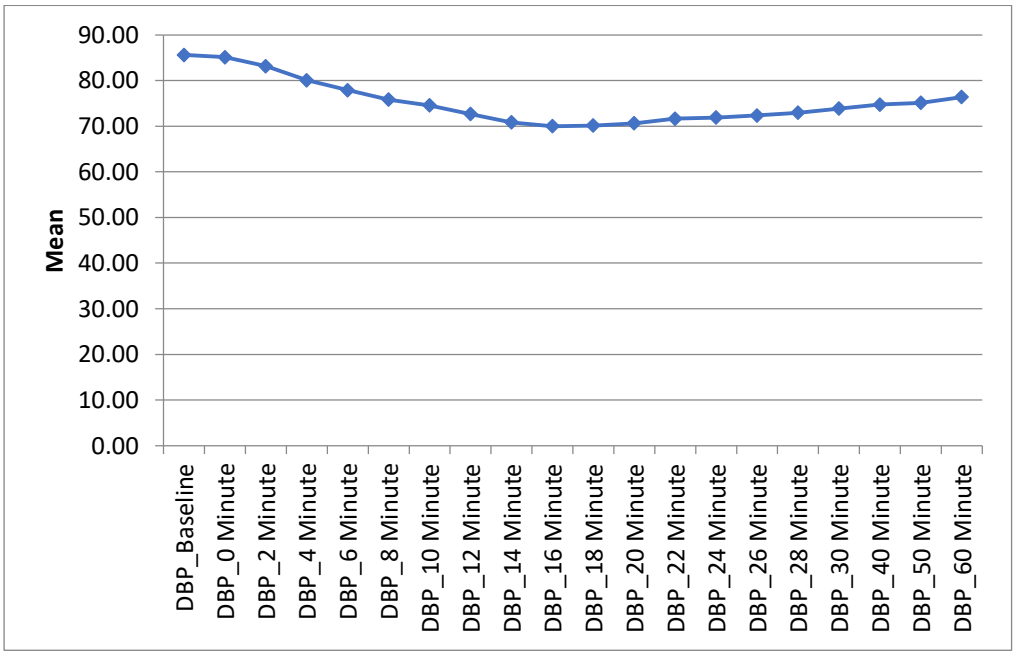


Figure 7: Intra-operative diastolic blood pressure of all patients

Table 9: Intra-operative mean arterial pressure of all patients

	N	Mean	SD	Minimum	Maximum
	Valid				
MAP_ Baseline	53	103.66	12.44	79.00	144.00
MAP_0 Minute	53	103.47	11.39	80.00	142.00
MAP_2 Minute	53	100.91	11.04	78.00	134.00
MAP_4 Minute	53	97.60	11.05	76.00	128.00
MAP_6 Minute	53	95.17	10.64	76.00	121.00
MAP_8 Minute	53	92.89	9.83	76.00	118.00
MAP_10 Minute	53	90.47	10.28	68.00	117.00
MAP_12 Minute	53	88.53	10.12	67.00	121.00
MAP_14 Minute	53	86.26	9.95	59.00	115.00
MAP_16 Minute	53	85.15	9.78	59.00	112.00
MAP_18 Minute	53	85.49	9.47	64.00	114.00
MAP_20 Minute	53	86.15	9.73	63.00	112.00
MAP_22 Minute	53	87.02	8.77	69.00	111.00
MAP_24 Minute	53	87.83	8.14	72.00	110.00
MAP_26 Minute	53	88.11	7.75	72.00	111.00
MAP_28 Minute	53	88.92	7.76	74.00	110.00
MAP_30 Minute	53	89.96	7.71	74.00	109.00
MAP_40 Minute	53	91.06	7.60	75.00	110.00
MAP_50 Minute	53	91.49	7.58	77.00	111.00
MAP_60 Minute	53	92.60	7.37	74.00	111.00

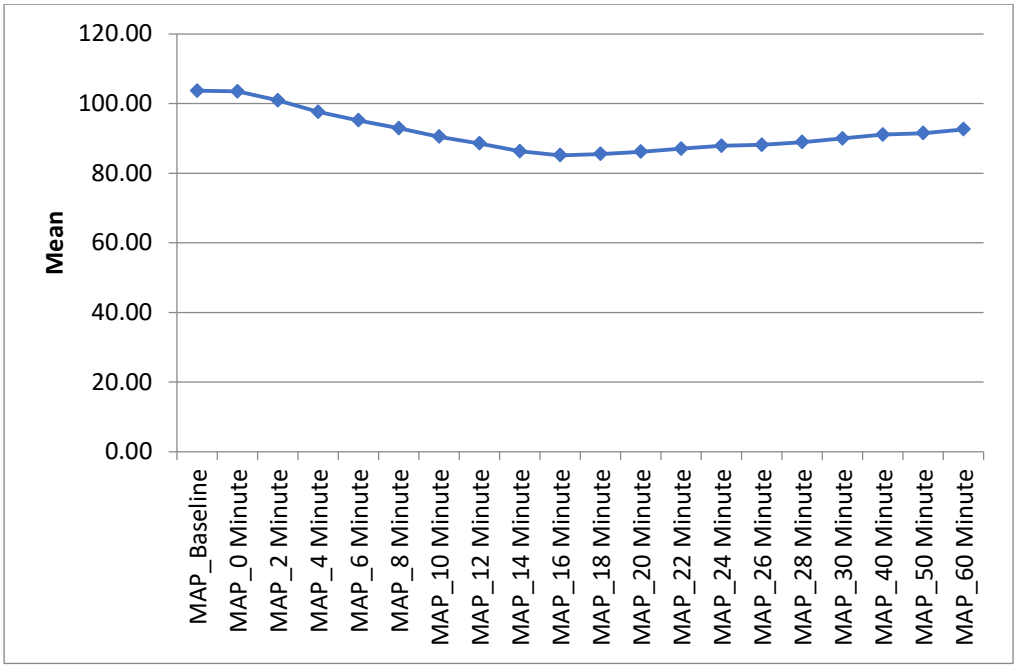


Figure 8: Intra-operative mean arterial pressure of all patients

Table 10: Intra-operative oxygen saturation of all patients

	N	Mean	SD	Minimum	Maximum
	Valid				
SPO2_Baseline	53	99.96	0.27	98.00	100.00
SPO2_0 Minute	53	99.98	0.14	99.00	100.00
SPO2_2 Minute	53	99.83	0.43	98.00	100.00
SPO2_4 Minute	53	99.62	0.53	98.00	100.00
SPO2_6 Minute	53	99.56	0.75	97.00	100.00
SPO2_8 Minute	53	99.62	0.63	98.00	100.00
SPO2_10 Minute	53	99.64	0.59	98.00	100.00
SPO2_12 Minute	53	99.53	0.77	97.00	100.00
SPO2_14 Minute	53	99.55	0.70	97.00	100.00
SPO2_16 Minute	53	99.66	0.62	97.00	100.00
SPO2_18 Minute	53	99.70	0.57	98.00	100.00
SPO2_20 Minute	53	99.68	0.70	97.00	100.00
SPO2_22 Minute	53	99.74	0.76	96.00	100.00
SPO2_24 Minute	53	99.70	0.70	96.00	100.00
SPO2_26 Minute	53	99.70	0.61	98.00	100.00
SPO2_28 Minute	53	99.62	0.66	98.00	100.00
SPO2_30 Minute	53	99.68	0.67	97.00	100.00
SPO2_40 Minute	53	99.79	0.45	98.00	100.00
SPO2_50 Minute	53	99.77	0.64	97.00	100.00
SPO2_60 Minute	53	99.85	0.41	98.00	100.00

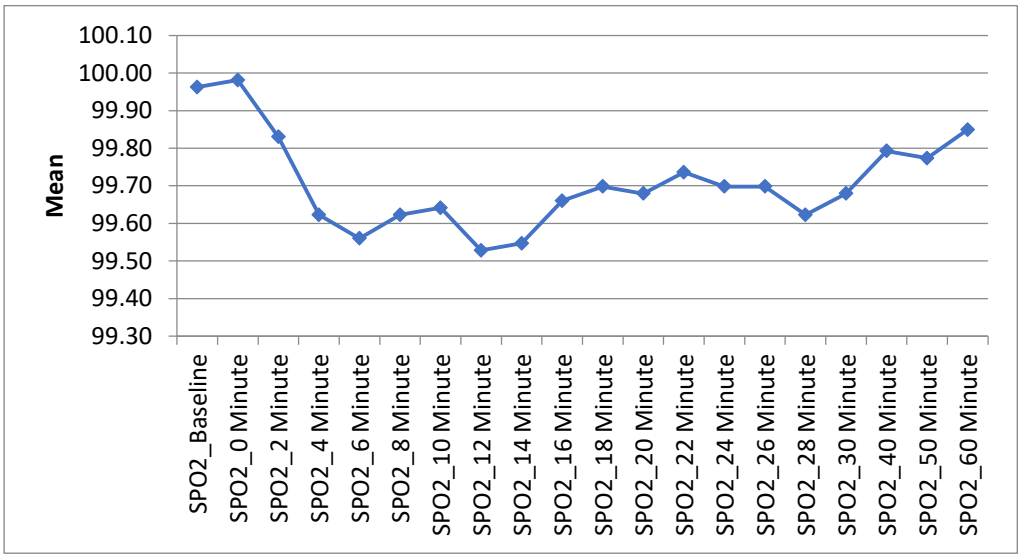


Figure 9: Intra-operative oxygen saturation of all patients

Table 11: Percentage of patients with post spinal hypotension

Post spinal hypotension	No. of cases	Percentage
No (N)	32	60.4%
Yes (Y)	21	39.6%
Total	53	100.0%

Post spinal hypotension occurred in 21 patients (39.6%) out of 53 and no patient had bradycardia after spinal anaesthesia.

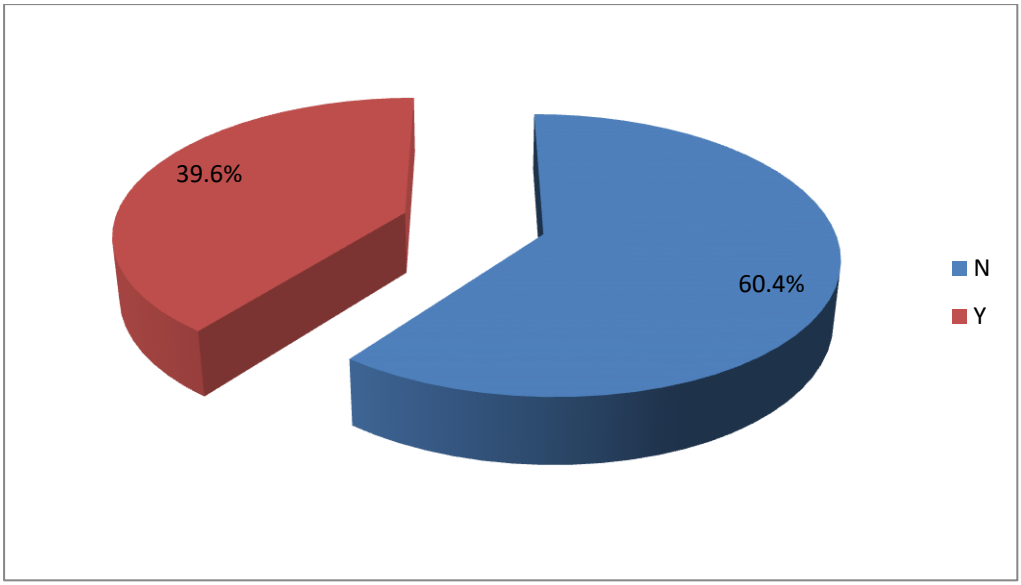


Figure 10: Percentage of patients with post spinal hypotension

Table 12: Maximum fall in blood pressure and heart rate in all the patients

	N	Mean	SD	Minimum	Maximum
Maximum % fall in BP	53	20.47	8.22	6.95	40.00
Maximum % fall in HR	53	14.02	6.62	0.10	31.30

The maximum mean percentage fall in blood pressure was 20.47±8.22%. The maximum mean percentage fall in heart rate was 14.02±6.62%

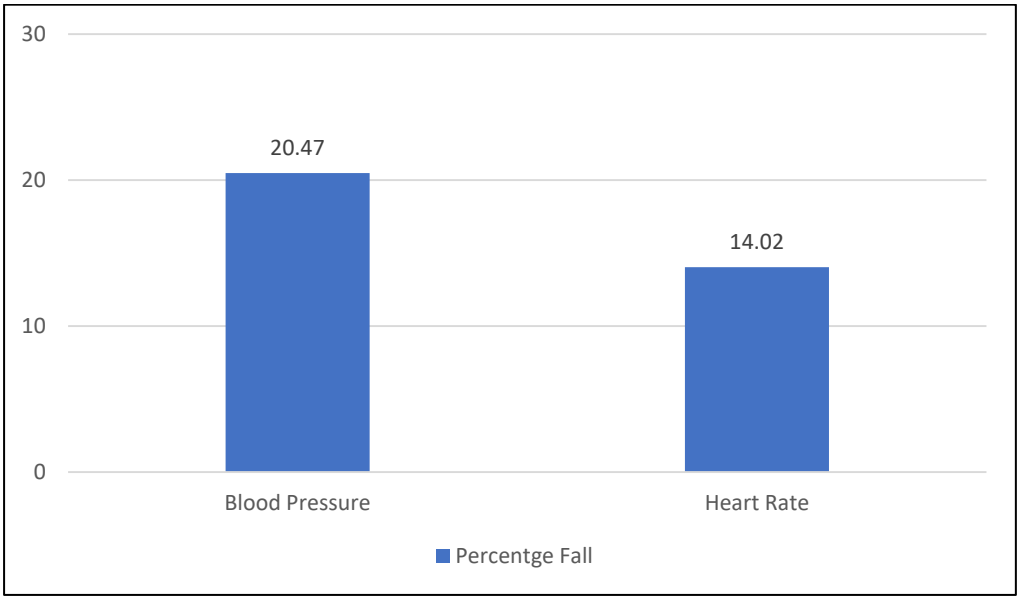


Figure 11: Maximum fall in blood pressure and heart rate in all the patients

Table 13: Comparison of gender in patients with and without post spinal hypotension

		Post spinal hypotension				Total	Chi-square value	p-value
		No		Yes				
Gender	F	6	50%	6	50%	12	0.698	0.403
	M	26	63.4%	15	36.6%	41		
Total		32	60.4%	21	39.6%	53		

Hypotension occurred in 15 males (36.6%) out of 26 males and 6 females (50%) out of total 12 females. The difference in gender was statistically insignificant in patients with and without post spinal hypotension.

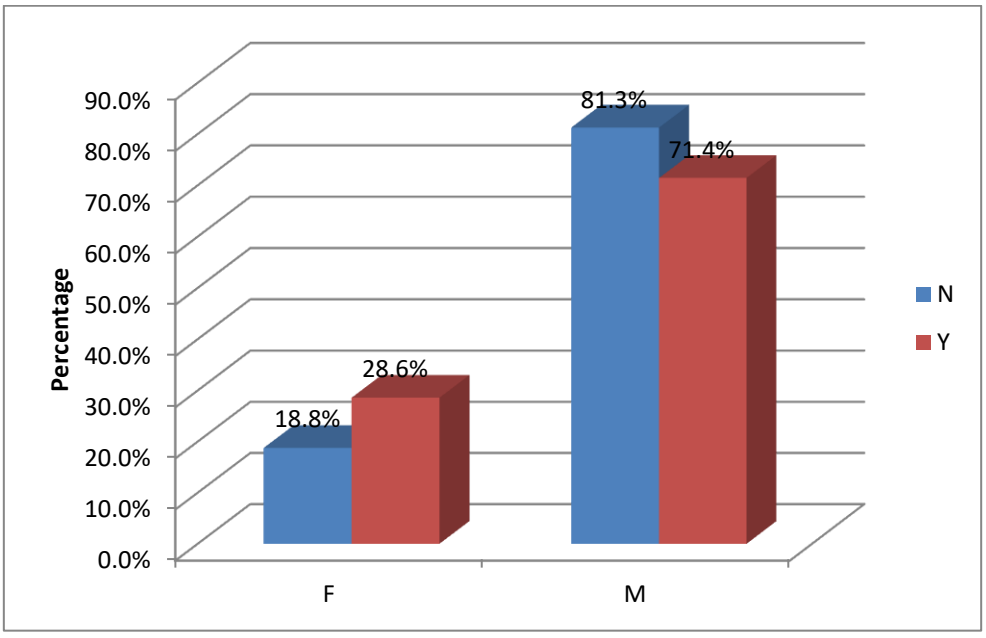


Figure 12: Comparison of gender in patients with and without post spinal hypotension.

Table 14: Comparison of age in patients with and without post spinal hypotension

	Post spinal hypotension					
	No		Yes		Z	p-value
	Mean	SD	Mean	SD		
Age (years)	43.25	13.34	44.05	17.07	-0.190	0.850

Hypotension occurred at mean age of 43.25±17.07 years. The mean age was comparable in patients with and without post spinal hypotension.

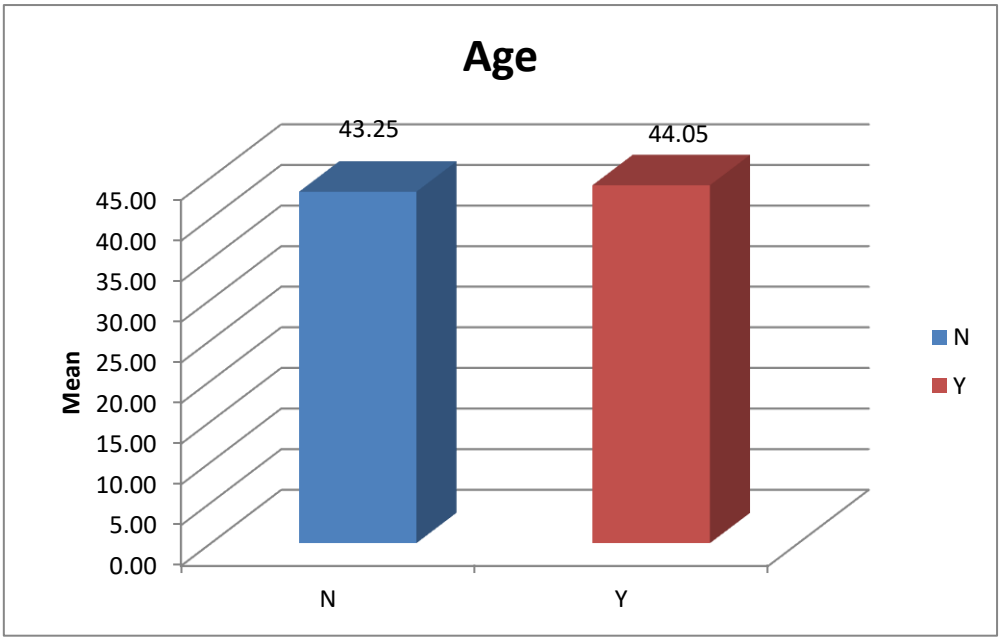


Figure 13: Comparison of age in patients with and without post spinal hypotension

Table 15: Comparison of weight, height and BMI in patients with and without post spinal hypotension

	Post spinal hypotension					
	No		Yes		Z	p-value
	Mean	SD	Mean	SD		
Weight (Kg)	74.38	14.87	78.52	21.86	-0.824	0.414
Height(cm)	169.72	8.16	169.52	8.48	0.084	0.934
BMI (Kg/m^2)	25.69	3.90	26.94	5.59	-0.962	0.341

The mean weight, height and BMI of patients was comparable in patients with and without post spinal hypotension with p value of 0.414, 0.934, 0.341 respectively.

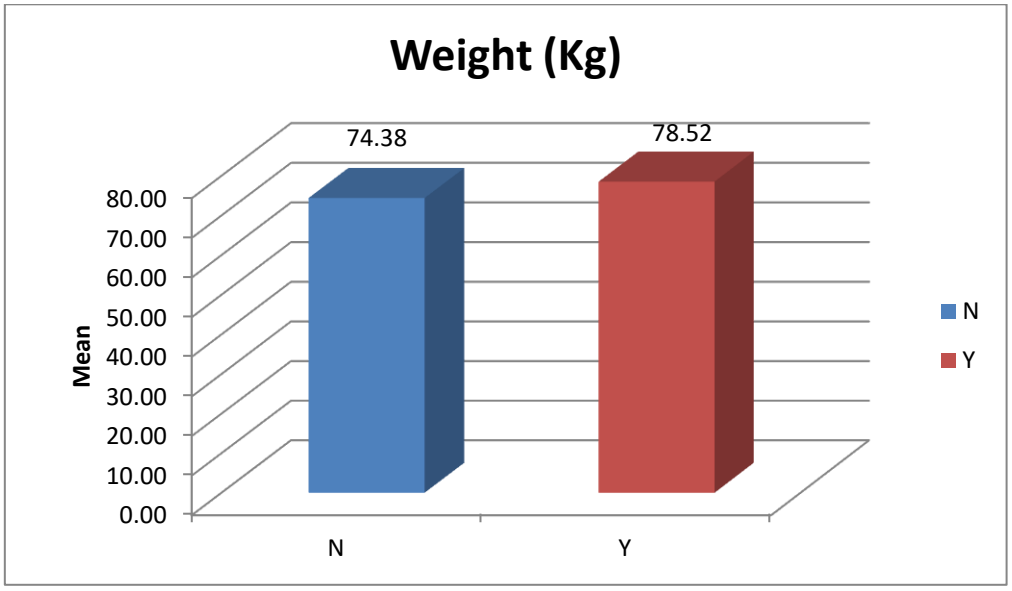


Figure 14: Comparison of weight in patients with and without post spinal hypotension

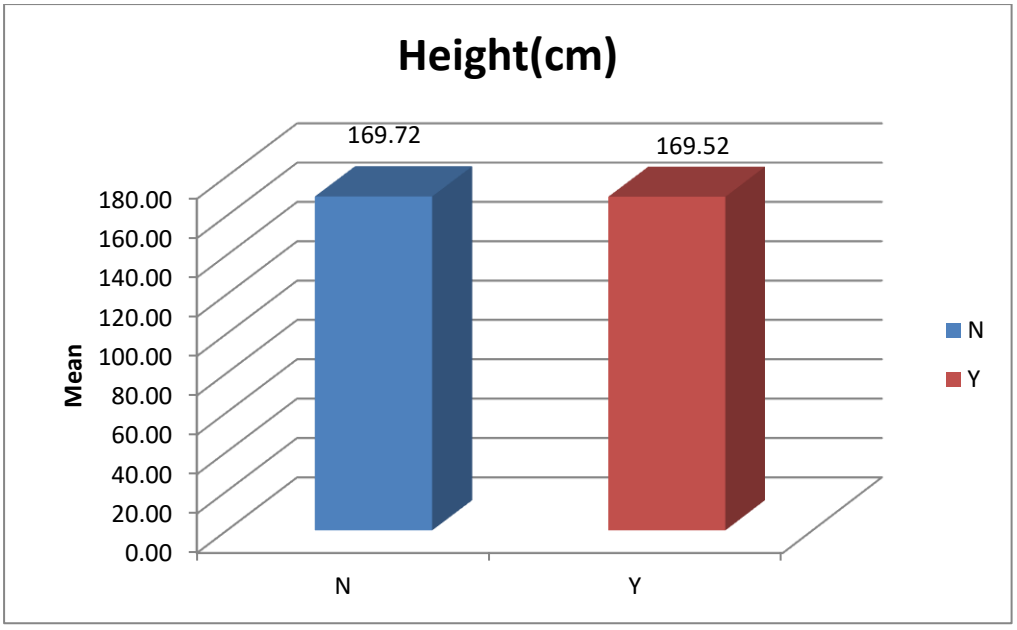


Figure 15: Comparison of height in patients with and without post spinal hypotension

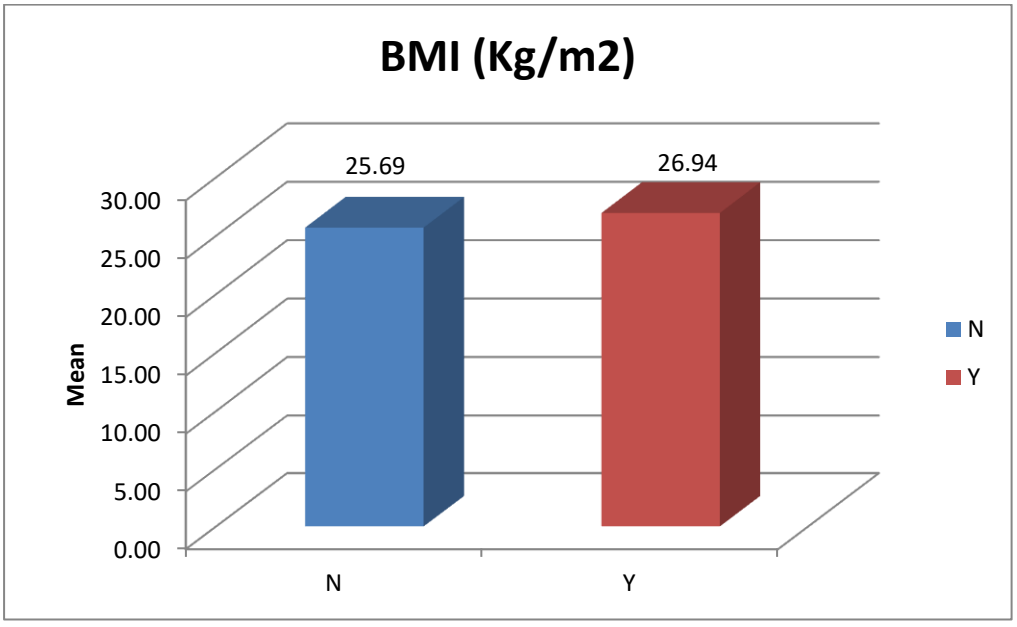


Figure 16: Comparison of BMI in patients with and without post spinal hypotension

Table 16: Comparison of ASA grade in patients with and without PSH

		Post spinal hypotension				Total	Chi-square value	p-value
		No	No	Yes	Yes			
ASA Grade	1	14	66.7%	7	33.3%	21	2.390	0.242
	2	13	50%	13	50%	26		
	3	5	83.3%	1	16.7%	6		
Total		32	60.4%	21	39.6%	53		

Hypotension occurred in 7 ASA 1 (33.3%) out of 21 ASA 1 patients, 13 ASA 2 (50%) out of 26 ASA 2 and 1 ASA 3 (16.7%) out of 6 ASA 3 patients. The difference in ASA Grade was not statistically significant in patients with and without post spinal hypotension.

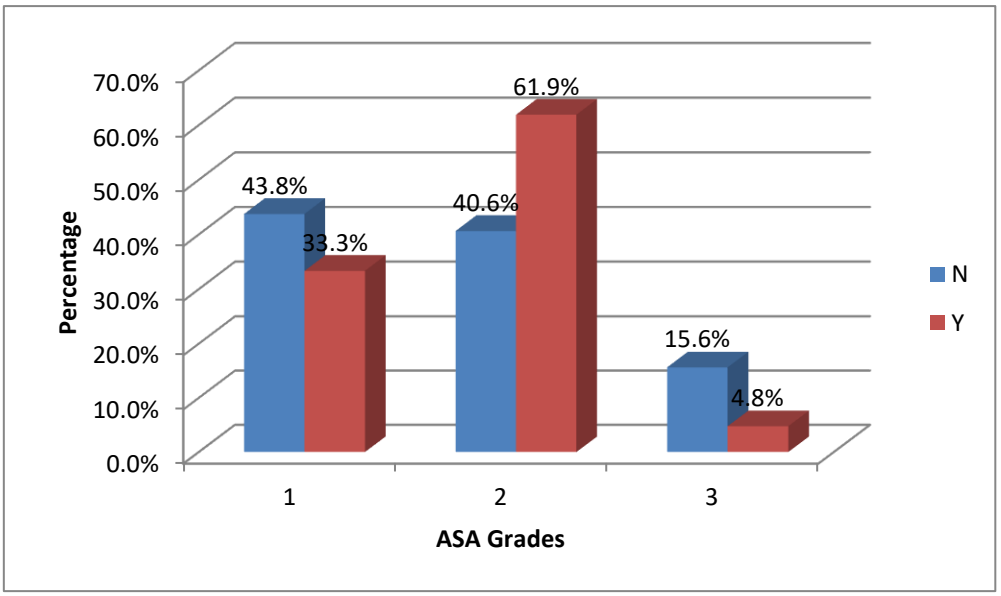


Figure 17: Comparison of ASA grade in patients with and without post spinal hypotension

Table 17: Comparison of highest level of sensory block achieved in patients with and without PSH

		Post spinal hypotension				Total	Chi-square value	p-value
		No		Yes				
Highest level of sensory block achieved	T3	0	0.0%	1	100.0%	1	13.289	0.065
	T4	2	50.0%	2	50.0%	4		
	T5	2	25.0%	6	75.0%	8		
	T6	5	55.6%	4	44.4%	9		
	T7	11	61.1%	7	38.9%	18		
	T8	10	100.0%	0	0.0%	10		
	T9	1	100.0%	0	0.0%	1		
	T10	1	50.0%	1	50.0%	1		
Total		32	60.4%	21	39.6%	53		

The highest level of sensory block was comparable in patients with and without post spinal hypotension.

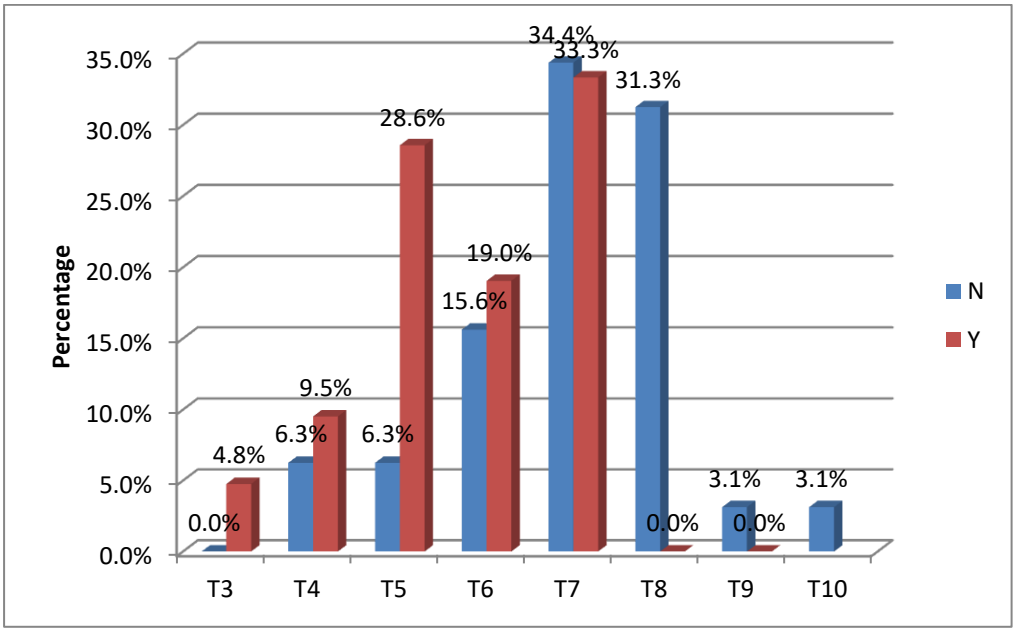


Figure 18: Comparison of highest level of sensory block achieved in patients with and without PSH

Table 18: Comparison of highest level of motor block achieved in patients with and without PSH

		Post spinal hypotension				Total
		No	No	Yes	Yes	
Highest degree of motor block achieved	MBS 3	32	100.0%	21	100.0%	53
Total		32	100.0%	21	100.0%	53

Highest degree of motor block achieved was MBS 3 in patients with and without PSH.

Table 19: Comparison of IJV parameters in patients with and without PSH

Post spinal hypotension	No		Yes		p-value	95% Confidence Interval
	Mean	SD	Mean	SD		
IJV _Maximum diameter (cm)	0.97	0.33	0.84	0.27	0.182	-0.05-0.29
IJV _Minimum diameter (cm)	0.82	0.31	0.64	0.24	0.054	0.02-0.34
IJV Collapsibility index %	16.14	6.68	24.84	9.71	**0.001**	-13.22-4.19

The differences in maximum and minimum IJV diameters were statistically insignificant between patients with and without post spinal hypotension. The IJV collapsibility index was significantly higher in the patients with post spinal hypotension. (p =0.001)

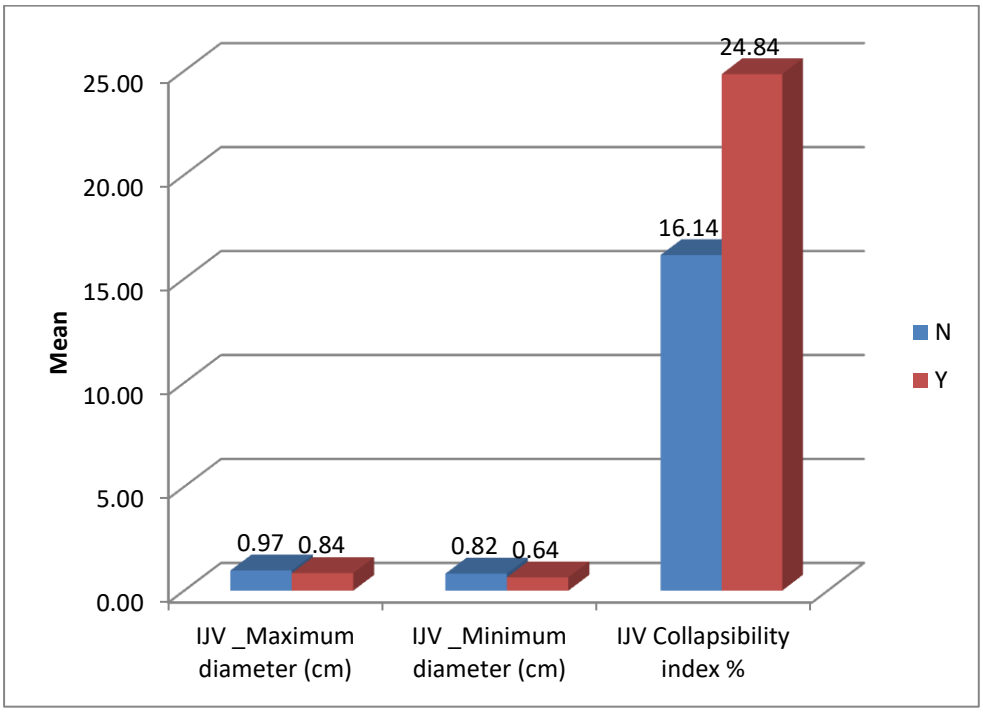


Figure 19: Comparison of IJV parameters in patients with and without PSH

Table 20: Comparison of CCA parameters in patients with and without PSH

Post spinal hypotension	No		Yes		p-value	95% Confidence Interval
	Mean	SD	Mean	SD		
Max. Carotid Peak velocity (cm/s)	19.23	5.56	17.06	4.23	0.229	5.04-0.69
Min. Carotid Peak velocity (cm/s)	17.04	5.11	14.27	3.82	**0.038**	5.39-0.15
Mean Carotid Peak Velocity (cm/s)	18.17	5.28	15.66	3.99	0.096	5.23-0.21
Carotid Artery Peak Systolic Velocity Variation %	12.11	5.25	18.24	7.58	**0.003**	-2.60-9.67

The differences in maximum and mean carotid peak velocity were statistically insignificant between patients with and without post spinal hypotension.

However, the minimum carotid peak velocity was significantly lower and carotid artery peak systolic velocity variation was significantly higher in the patients with post spinal hypotension.

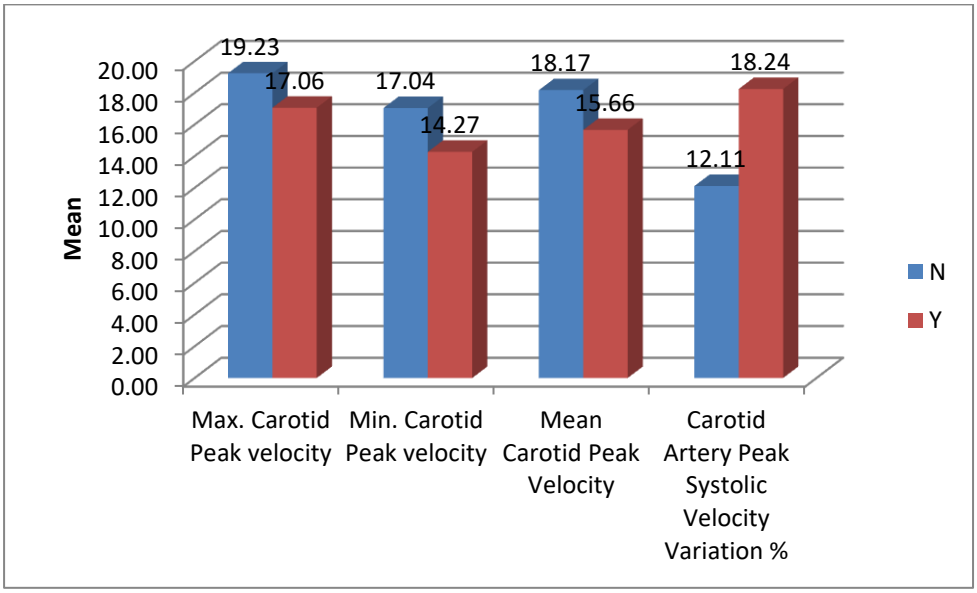


Figure 20: Comparison of CCA parameters in patients with and without PSH

Table 21: ROC curve of IJV collapsibility index

	Test Result Variable: IJV Collapsibility Index				
Area	Cut Off	Std. Error[a]	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
0.769	21.58	0.068	**0.001**	0.636	0.903

The area under curve for IJV collapsibility index is 0.769 with cut off value 21.58% and 95% CI (0.903-0.636) with a p value of 0.001 which is statistically significant.

ROC CURVE ANALYSIS

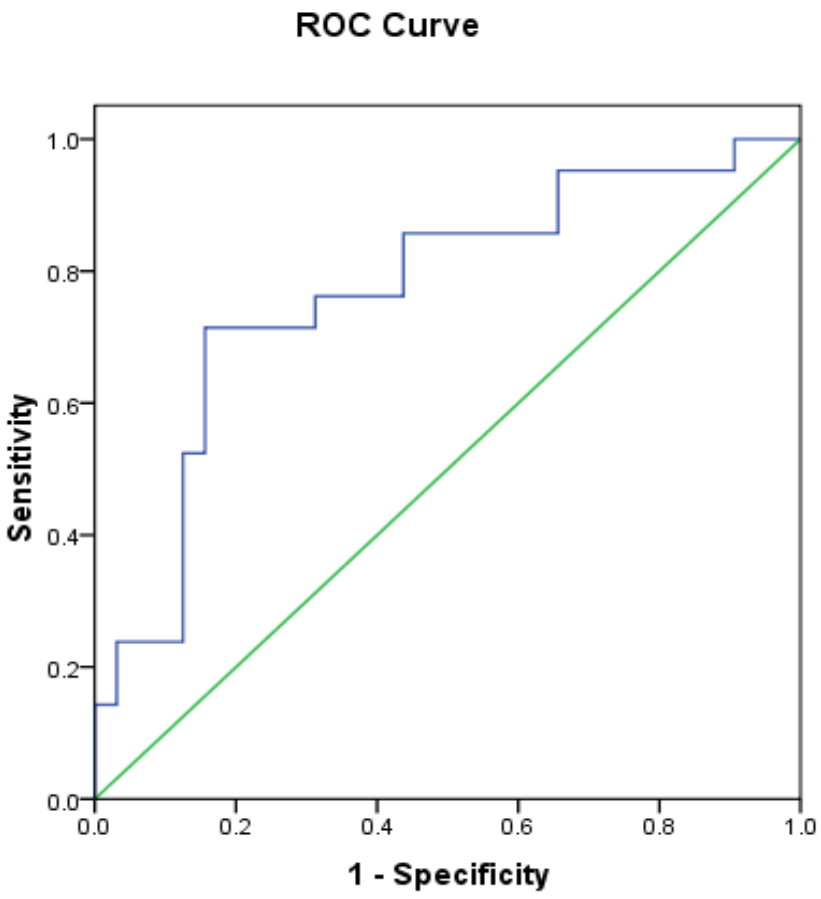


Figure 21: ROC curve of IJV collapsibility index

Table 22: ROC curve of carotid artery peak systolic velocity variation

	Test Result Variable: Carotid artery peak systolic velocity variation				
Area	Std. Error[a]	Cut Off	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
.760	.066	12.16	**0.002**	0.631	0.888

The area under curve for carotid artery peak systolic velocity variation is 0.760 with cut off value 12.16% and 95% CI (0.888-0.631) with a p value of 0.002 which is statistically significant.

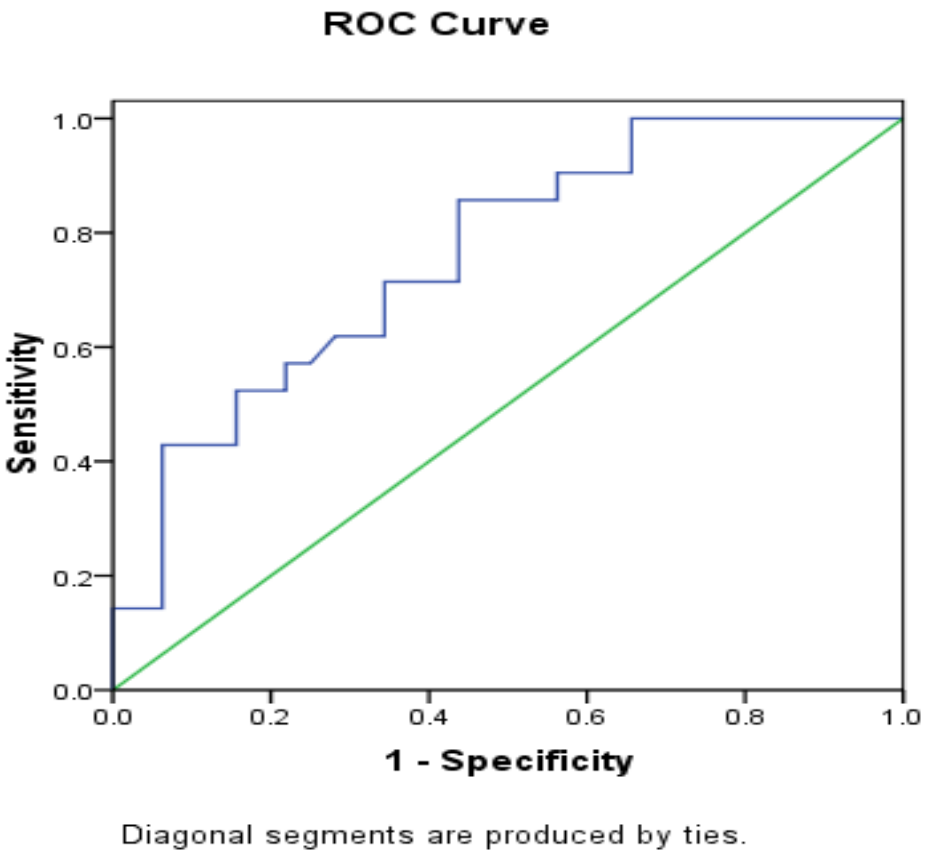


Figure 22: ROC curve of carotid artery peak systolic velocity variation

Table 23: Association of IJV collapsibility index in prediction of post spinal hypotension at cut off value of 21.58%

		Post spinal hypotension				Total	Chi-Square value	p-value
		No		Yes				
IJV Collapsibility index%	< 21.58	27	84.4%	6	28.6%	33	16.804	**0.001**
	> 21.58	5	15.6%	15	71.4%	20		
Total		32	100.0%	21	100.0 %	53		

Table 24: Diagnostic profile for IJV collapsibility index in prediction of post spinal hypotension at cut off value of 21.58%

Statistic	Value	95% CI
Sensitivity	71.43%	47.82% to 88.72%
Specificity	84.38%	67.21% to 94.72%
Positive Likelihood Ratio	4.57	1.96 to 10.69
Negative Likelihood Ratio	0.34	0.17 to 0.68
Disease prevalence (*)	39.62%	26.45% to 54.00%
Positive Predictive Value (*)	75.00%	56.20% to 87.52%
Negative Predictive Value (*)	81.82%	69.24% to 89.99%
Accuracy (*)	79.25%	65.89% to 89.16%

IJVCI cutoff value of 21.58% predicted PSH with sensitivity and specificity of 71.43% and 84.38% respectively, having a NPV of 81.82% and 79.25% accuracy (p value =0.001)

Table 25: Association of carotid artery peak systolic velocity variation in prediction of post spinal hypotension at cut off value of 12.16%

		Post spinal hypotension				Total	Chi-Square value	p-value
		No		Yes				
Carotid artery peak systolic velocity variation%	< 12.16	18	56.3%	3	14.3%	21	9.33	**0.004**
	> 12.16	14	43.8%	18	85.7%	32		
Total		32	100.0%	21	100.0%	53		

Table 26: Diagnostic profile for carotid artery peak systolic velocity variation in prediction of post spinal hypotension at cut off value of 12.16%

Statistic	Value	95% CI
Sensitivity	85.71%	63.66% to 96.95%
Specificity	56.25%	37.66% to 73.64%
Positive Likelihood Ratio	1.96	1.27 to 3.01
Negative Likelihood Ratio	0.25	0.09 to 0.76
Disease prevalence (*)	39.62%	26.45% to 54.00%
Positive Predictive Value (*)	56.25%	45.55% to 66.40%
Negative Predictive Value (*)	85.71%	66.83% to 94.70%
Accuracy (*)	67.92%	53.68% to 80.08%

Carotid artery peak systolic velocity variation cutoff value of 12.16% predicted PSH with sensitivity and specificity of 85.71% and 56.25% respectively, having a NPV of 85.71% and 67.92% accuracy (p value =0.004).

CORRELATION

Table 27: Correlation between carotid artery peak systolic velocity variation % and maximum % fall in BP

Spearman's rho		Maximum % fall in BP
Carotid artery peak systolic velocity variation %	Correlation coefficient r	0.483
	p-value	**0.0002**
	N	53

On comparing carotid artery peak systolic velocity variation % with Maximum % fall in BP a moderate positive correlation was present which was statistically significant (r= 0.483, p = 0.0002).

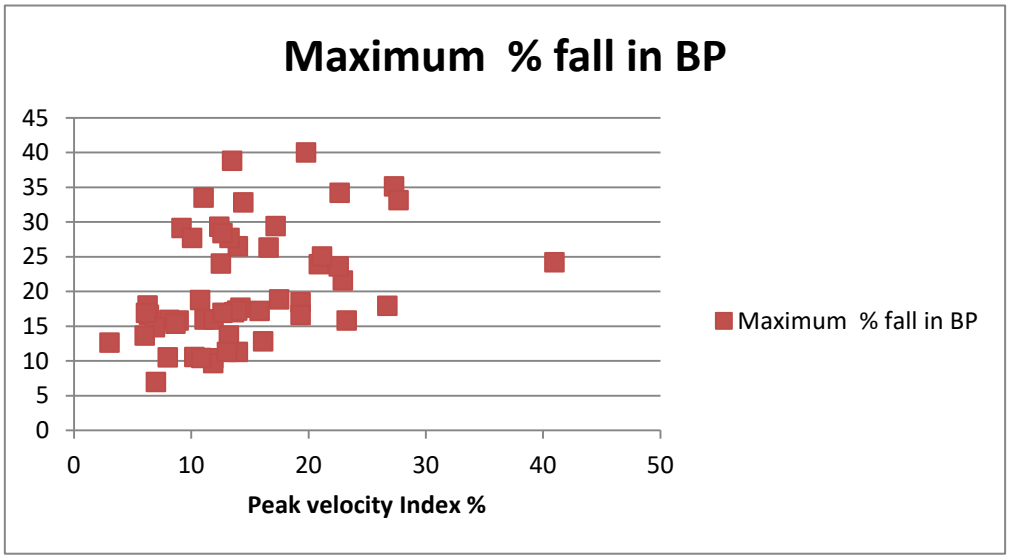


Figure 23: Correlation between carotid artery peak systolic velocity variation % and maximum % fall in BP

Table 28: Correlation between IJV collapsibility index % and maximum % fall in BP

Spearman's rho		Maximum % fall in BP
IJV Collapsibility Index %	Correlation coefficient r	0.298
	p-value	**0.030**
	N	53

On comparing IJV collapsibility index % with maximum % fall in BP a low positive correlation was present that was statistically significant (r=0.298, p = 0.030)

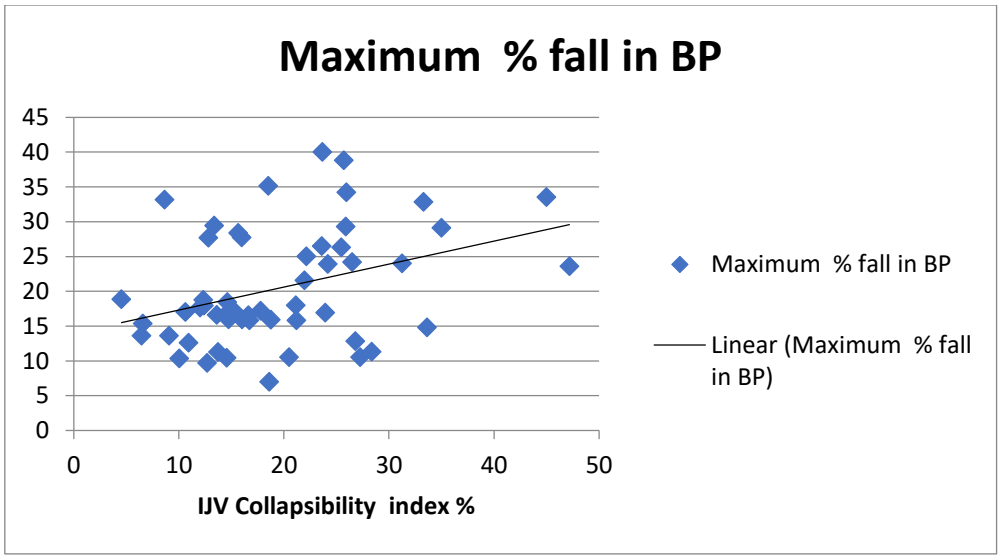


Figure 24: Correlation between IJV Collapsibility Index % and maximum % fall in BP

Table 29: Comparison of CAPVV% between patients with and without post spinal hypotension.

		Post spinal hypotension				Total	Chi-Square value	p-value
	CAPVV %	No		Yes				
CAPVV group %	1.0-11.9	18	56.3%	3	14.3%	21	11.199	**0.011**
	12-21.9	12	37.5%	12	57.1%	24		
	22-31.9	2	6.3%	5	23.8%	7		
	> 32	0	0.0%	1	4.8%	1		

Among patients without PSH 56.3% (18) had CAPVV less than 12 %. While 85.7% (18) of the patients with PSH had CAPVV more than 12 %.

In a range of CAPVV 1-11.9 %, only 14.3% (3) developed PSH, while 56.3% (18) had no PSH.

In a range of CAPVV 12-21.9 %, 50% (12) developed PSH and 50 % (12) had no PSH.

In a range of CAPVV 22-31.9%, 71.4% (5) developed PSH and 28.5% (2) had no PSH.

In a range of CAPVV 32 % and above, 100% (1) of patients developed PSH

Hence the higher the CAPVV more are the chances of post spinal hypotension. The association was found to be statistically significant(p value = 0.011).

Table 30: Comparison of IJV collapsibility index % between patients with and without post spinal hypotension

		Post spinal hypotension				Total	Chi-Square value	p-value
	IJVCI %	No		Yes				
IJV Collapsibility index % group	1-11.9	7	21.9%	1	4.8%	8	15.32	**0.004**
	12-21.9	20	62.5%	6	28.6%	26		
	22-31.9	4	12.5%	10	47.6%	14		
	32-41.9	1	3.1%	2	9.5%	3		
	> 42	0	0.0%	2	9.5%	2		

Among patients without PSH 84.4% (27) had IJVCI less than 22 %. While 66.6% (14) of the patients with PSH had IJVCI more than 22 %.

In a range of IJVCI 1-11.9 %, only 12.5% (1) developed PSH, while 87.5% (7) had no PSH.

In a range of IJVCI 12-21.9 %, 23.07% (6) developed PSH, while 76.93% (20) had no PSH.

In a range of IJVCI 22-31.9 %, 71.4% (10) developed PSH, while 28.57% (4) had no PSH.

In a range of IJVCI 32-41.9 %, 66.6% (2) developed PSH, while 33.33% (1) had no PSH.

In a range of IJVCI 42 % and above, 100% (2) of patients developed PSH.

Hence the higher the IJVCI more are the chances of post spinal hypotension. The association was found to be statistically significant (p value = 0.004).

DISCUSSION

Hypotension after spinal anaesthesia is a common complication that is a matter of concern for anesthesiologist. It can lead to decreased perfusion to vital organs of body leading to myocardial injury, ischemic stroke, acute kidney injury and is linked to unfavorable patient outcomes[54] The capacity to anticipate which patients are more likely to experience hypotension allows anesthesiologist to optimize patients before giving sub arachnoid block.

Many strategies have been developed to determine and prevent the hypotension like assessment of fluid status with central venous catheter, using pulmonary artery catheter, transthoracic echocardiography however these methods are invasive, time consuming and have their own complications. Point of care ultrasound is a reliable and non-invasive tool for identifying patients at risk of developing hypotension after sub arachnoid block. The major vessels can be ultasonographically evaluated at the patient's bedside to provide a highly specific and sensitive assessment of the intravascular volume status and response to fluid administration. According to Ayyanagouda[55] and Elbadry et al[46], ultrasonography guided fluid administration is an efficient way to prevent post-spinal hypotension.

Larger vessels, such as internal jugular vein, common carotid artery in the neck, and the inferior vena cava are frequently used for assessment of the intravascular volume status. Parameters such as IJV diameter, IJV collapsibility index, IVC diameter, IVC collapsibility index, and corrected blood flow time of the carotid artery have shown to be reliable and accurate when determining the patient's volume status.[23,45,56] The inferior vena cava collapsibility index which is a measure of variation in IVC diameter with respiration, provides a reliable, non-invasive way to determine fluid status. However, IVCCI measurements are sometimes not possible or technically challenging in some patients, because of obesity, raised intra-abdominal pressure, large intra-abdominal mass, excessive gas in bowel, dressings, or large amounts of intra-thoracic air or fluid.[19] The measurement of IJV

and carotid artery parameters is relatively easy and convenient when compared to IVC evaluation. The IJV and carotid artery located in the neck can be easily identified by using high frequency ultrasonography probe. IJV collapsibility index and carotid artery peak systolic velocity variation assessments are derived from the IJV diameters and carotid artery peak velocities measured during inspiration and expiration. Studies have individually revealed IJV collapsibility index and CCA peak systolic velocity variation as reliable and accurate parameters for fluid assessment.[23,44,52] In our study we aimed to compare the efficacy and predictive value of both IJV collapsibility index with CCA peak systolic velocity variation in prediction of hypotension post spinal anaesthesia in same patient.

In our study 53 patients, scheduled for elective surgery under spinal anaesthesia were enrolled after obtaining informed consent. Both IJVCI and CAPVV were evaluated and compared for prediction of hypotension post spinal anaesthesia.

Demographic parameters such as age, gender, BMI, etc may act as confounding factor for development of post spinal hypotension, but in our study, there was no statistically significant difference in these parameters among patients, with and without development of post spinal hypotension. In a study by Kayhan et al [47] the age and BMI of the patients in the hypotensive group was more than the non-hypotensive group.

A reduction of systolic blood pressure more than or equal to 20% of the baseline value is defined as post spinal hypotension in most of the studies in literature [53,57]. In our study, 39.6% (21 out of 53) patients had post spinal hypotension and this finding is in concordance with the study conducted by Jeon et al[58] where incidence of hypotension was 41%. Our study's findings were also similar to the results of Chowdhury et al[50], who found that 34% of patients experienced hypotension following subarachnoid block. In contrast to our study, 47% incidence of hypotension was reported by Elbardy et al[46], where the higher incidence of hypotension can be attributed to inclusion of obstetric population in their study, as they are more vulnerable to hypotension

post sub-arachnoid block. Moreover, Abdelhamid et al observed 66.2% incidence of post spinal anaesthesia hypotension, this high incidence might be due to geriatric participants who are more prone to profound sympathetic block. [45]

In our study, a greater incidence of PSH was found with highest level of sensory block higher than ≥T5. Our results were consistent with a study by Zhang et al[59] that found when the level of sensory block was higher than ≥T5, parturients had a high incidence of hypotension after spinal anesthesia. Chinachoti et al[57] also found a similar result with high incidence of hypotension when level of sensory block was ≥T5 post sub arachnoid block.

In our study, the IJV diameter was assessed ultrasonographically. The IJV collapsibility index was derived from the vessel diameters. The mean IJVCI value was 24.84% in patients with post spinal hypotension and 16.14% in the patients without post spinal hypotension. The patients with PSH had significantly higher IJVCI value than patients without PSH ($p = 0.001$). The cutoff value of IJVCI calculated was 21.58% with sensitivity and specificity of 71.43% and 84.38% respectively with 79.25% accuracy for predicting PSH. The area under ROC curve was 0.769 with cut off value 21.58% (95% CI [0.903-0.636], $p = 0.001$.)

Similarly, in a study by Kılıç et al [44] conducted on 47 patients between the age group of 18 to 65 years, 46.7% patients developed post spinal hypotension. The baseline characteristics and the demographic profile of the two groups were similar, however the IJVCI values found were significantly different between the two groups. The IJVCI was found to be a moderate predictor of PSH with cut-off value of 22.6%. They reported an area under ROC curve of 0.709, sensitivity of 64%, and specificity of 63.6% with p value= 0.014. The findings and cut-off value of this study were comparable to ours.

In our study 21 out of total 53 subjects (39.6%) developed hypotension while in a study by Abdelhamid et al [45], 47 out of 71 patients (66.2%) developed hypotension post spinal anaesthesia. The high incidence of hypotension (66.2%) can be due to the geriatric population (>60 years)

included in their study. In old age there occurs some physiological changes like reduction in central venous pressure (CVP), cardiac output, and left ventricular end-diastolic volume and an increase in basal sympathetic tone which might have resulted in increased incidence of hypotension post sub arachnoid block. They found that patients with PSH had significantly lower maximum and minimum IJV diameters 0.82 ± (0.34) cm, 0.53 ± (0.32) cm respectively when compared to patients without PSH. We also obtained similar values of diameter with maximum and minimum IJV diameters 0.84± (0.27), 0.64 ± (0.24) cm respectively in patients with PSH. Abdelhamid et al concluded that diameter values were lower in patients who developed PSH compared to patients who did not develop PSH.

The cut off value of IJVCI for prediction of PSH found by Abdelhamid et al was >34.4% with sensitivity of 61.70% and specificity of 79.17% which was different from our calculated cut off value of 21.58% with sensitivity and specificity of 71.43% and 84.38% respectively. With an area under receiver operating characteristic curve of 0.69 (95% CI-0.578–0.802) Abdelhamid et al found IJVCI to be a moderate predictor of hypotension post spinal anaesthesia.

Besides the use of IJVCI as a predictor of hypotension post spinal anaesthesia, it was also used for prediction of hypotension post induction in general anaesthesia by Kayhan et al [47] among 47 patients who underwent elective surgery under general anaesthesia. The IJVCI was measured in the trendelenburg position prior to the induction of anaesthesia. The incidence of hypotension occurred in 24 patients (60%). With an area under curve of 0.704 IJV collapsibility index in the trendelenburg position had a cut-off point of 19.9% with 62% sensitivity and 62% specificity to predict the episode of hypotension post induction of anaesthesia and was considered a reliable indicator. There was a difference in the demographic profile of the two groups compared. Patients in the postinduction hypotension group had higher baseline blood pressure readings, were older, and had a higher BMI than those in the non-hypotensive group, which contributed to the higher incidence of hypotension.

According to a study by Bilgili et al, IJVCI greater than 36% predicted hypovolemia and fluid responsiveness in sepsis with a sensitivity and specificity of 78% and 85%, respectively in patients admitted in intensive care unit. [24] The purpose of this research was to confirm the viability and utility of the internal jugular vein collapsibility index (IJV-CI) in conjunction with the inferior vena cava collapsibility index (IVC-CI) for the purpose of predicting fluid responsiveness in patients with sepsis. With a cut-off value of ≥35% (78% sensitivity, 85% specificity), IVCCI was also found to be the predictor of hypovolemia. IJV-CI was found to be a reliable, easy-to-acquire, non-invasive measure of fluid responsiveness and appeared to be a suitable supplement to IVC-CI. In another study for bedside assessment of central venous pressure and fluid status in critically ill patients using ultrasonography by Ibrahim et al[42] admitted in the surgical intensive care units. The IJVCI was found to be on lower side in cases with CVP greater than 10 mmHg compared to cases where CVP was less than 10. When predicting CVP ≤ 10, the IJVCI had a cut off > 21.4% with sensitivity of 88.4%, specificity of 79.2%, and accuracy of 85.1% The results of study revealed IJV collapsibility index and clinical volume status were well correlated.

IJVCI was also used to predict hypotension post spinal anaesthesia in pregnant females in a study by Elbadry et al [46]. A 47.27% incidence of PSAH was observed in 55 pregnant female patients posted for caesarean section. The results showed that IJVCI was a reliable indicator of hypotension post spinal anaesthesia. Higher cut off values of 38.5% with sensitivity and specificity of 84.6 and 82.8% respectively in prediction of PSH were reported in contrast to our study. However, in our study we excluded pregnant females which might have led to lower cut off ranges.

A similar study by Pharanitharan N et al[48] was conducted in 91 pregnant women who underwent elective lower segment caesarean sections. They reported cut-off point of 29.5% of IJVCI for prediction of PSH with a sensitivity of 70% and specificity of 23%. With an area under ROC curve of 0.554, study by Pharanitharan N et al[48] revealed

that IJVCI was not a reliable indicator to predict PSH in pregnant females who are more susceptible to hypotension in comparison to non-pregnant patients. Although higher mean values of IJVCI were observed in patients with PSH than patients without PSH did, which were similar to the findings of our study.

Accurate IJVCI evaluation has a crucial role in fluid assessment and responsiveness. Studies have shown the IJVCI as a reliable indicator for post spinal hypotension prediction. On the other hand, recent research conducted by authors Pharanitharan N et al.[48], Derya et al[60] have determined that IJVCI was not an adequate predictor of post-spinal hypotension. Hence it is debatable whether IJVCI is a reliable indicator of post-spinal hypotension. Therefore, we conducted an ultrasonographic analysis of the carotid artery to predict hypotension. Recent studies by Beier et al[25], Song et al[27], Roy et al[51] have shown carotid artery parameters like carotid cross-sectional area, peak systolic velocity variation to be reliable and accurate when determining the patient's volume status. We evaluated CCA peak systolic velocity variation which describes how changes in respiratory fluctuations cause the carotid pulse upstroke's amplitude to change. We analysed CAPVV for prediction of hypotension post sub arachnoid block.

Using ultrasonographic wave doppler, maximum and minimum carotid artery peak systolic velocities were measured in one respiratory cycle. Carotid artery peak systolic velocity variation was derived from the carotid velocities. It was found that the mean CAPVV was 18.24% in patients who had hypotension and 12.11% in the patients who had no hypotension. The patients who developed hypotension expressed significantly higher CAPVV value than with patients who did not develop hypotension ($p = 0.003$).

In our study we calculated cutoff value of 12.16% for CAPVV with sensitivity and specificity of 85.71% and 56.25% respectively with 67.92% accuracy for predicting PSH. With area under ROC curve as 0.760 we found cut off value of 12.16% (95% CI [0.888-0.631] p value = 0.004).

In a systematic review conducted by Beier et al[25] in 956 patients for assessment of volume responsiveness using carotid ultrasound measurements, data from 17 studies was analysed. They reported a cut off ranging between 9% to 14% with AUROC 0.81 to 0.91. The sensitivity ranging between 73% to 86% and specificity ranging between 78% to 86%. A similar cut off value of CAPVV 11% was found in the study by Song et al[27] with sensitivity of 85% and specificity of 82% and AUROC of 0.85 with 95% CI (0.72-0.97) and a significant p value of 0.001. They concluded that doppler assessment of carotid artery is a reliable method for predicting fluid responsiveness in mechanically ventilated patients

The predictive accuracy of CAPVV and carotid corrected flow time in relation to fluid responsiveness was evaluated by Singla et al.[52] through a systematic review and meta-analysis. A total of ten studies that met the inclusion criteria were chosen. With respect to pooled sensitivity and specificity, CAPVV exhibited values of 0.83 and 0.81 respectively. The AUC of the CAPVV summary receiver operating characteristic curve (SROC) was 0.8941.

In contrast to our study Maitra et al[56] reported optimum cutoff value of CAPVV for prediction of hypotension to be 18.8% with sensitivity (61.9%) and specificity (67.4%) lower than our study with an AUROC curve of 0.68 with 95% CI (0.58–0.78). The factors that made CAPVV not a reliable predictor in their study could be inclusion of ASA I, ASA II patients, not the elderly or sick patients for whom the risk of hypotension increases.

Another study by Chowdhury et al [50] done in 50 adult patients aged between 18 and 65 years posted for elective lower abdominal surgeries under spinal anaesthesia aimed to evaluate and compare the role of IVCCI and CAPVV in prediction of PSH. The patients were split into two groups: PSHY (with PSH) and PSHN (without PSH). Between the two groups, all demographic and hemodynamic data were comparable. A total of 17 patients (34%) developed PSH. Chowdhury et al[50] also reported the cut off value of 18.33 % which was higher in comparison to our study (12.16%). The sensitivity (70.6%) was lower where as the

specificity (54.6%) reported was similar to our study with area under ROC of 0.639. It was concluded that CAPVV was not a good evaluation tool for prediction of PSH.

In our study Spearman correlation coefficient was used to find out correlation between the parameters of CAPVV, IJVCI and maximum fall in BP. It was observed that the association of IJVCI and post spinal maximum fall in BP had a positive correlation (r= 0.298) that was statistically significant (p = 0.030). This indicates that higher the IJVCI value, more are the chances of hypotension.

CAPVV had a moderate positive correlation (r= 0.483) with maximum percent fall in BP. This finding was statistically significant (p = 0.0002). This infers to the higher the CAPVV, greater will be the maximum percent fall in BP.

In our study, the cut off value was 21.58% for IJVCI for the prediction of post spinal hypotension. On grouping the data we found that 84.4% $^{(27)}$ of the patients without PSH had IJVCI less than 22 %. Whereas 66.6% $^{(14)}$ of the patients with PSH had IJVCI more than 22 %. It infers to IJVCI value lower than 22 % had less chances of PSH.

For CAPVV a cutoff value of 12.16% was observed. The data analysis showed 56.3% $^{(18)}$ of the patients without PSH had CAPVV less than 12 %. While 85.7% $^{(18)}$ of the patients with PSH had CAPVV more than 12 %. Therefore CAPVV value above 12% had more chances of PSH.

On comparison between two parameters, a similar AUROC of 0.769 and 0.760 for IJVCI and CAPVV respectively was observed. The IJVCI had a better specificity of 84.38% and the CAPVV had a better sensitivity of 85.71%. Accuracy as defined in literature refers to the closeness of a measurement to the true value of the quantity being measured was better with IJVCI (79.25%) than CAPVV (67.92%) in our study for the prediction of post spinal hypotension.

Limitations of our study

1) The study was single centre observational study with relatively small number of patients

2) The study was performed only on elective surgical cases.

3) The IJV and carotid artery measurements are affected by the respiratory efforts and different breathing patterns.

Strengths of our study

1) There was no inter-evaluator variability because only one evaluator conducted all of the measurements.

2) This is first study to assess and compare the diagnostic efficacy of ultrasonographic IJV measurements with ultrasonographic carotid artery measurements for prediction of postspinal hypotension.

SUMMARY AND CONCLUSION

The current study to evaluate and compare the predictive value of internal jugular vein collapsibility index and common carotid artery peak systolic velocity variation in prediction of post spinal hypotension was carried out in the Department of Anaesthesiology, Dayanand Medical College and Hospital, Ludhiana after obtaining Institutional ethical committee approval.

A total of 53 adult ASA grade I, II and III patients undergoing elective surgery under spinal anaesthesia, were included in the study after obtaining a written informed consent. After sign in proceedings, standard monitoring was started and baseline vitals were recorded. Internal jugular vein collapsibility index (IJVCI) and common carotid artery peak systolic velocity variation (CAPVV) were measured and recorded before giving sub-arachnoid block. Sub-arachnoid block was given using 12.5mg Bupivacaine Heavy 0.5% (2.5ml) with 25 µg Fentanyl (0.5 ml) as adjuvant and surgery was permitted when required level of anaesthesia was achieved. Regular vital monitoring was done every 2 minutes till 30 minutes as per standard protocol. Hypotension as defined by a fall in the systolic blood pressure more than or equal to 20% of the baseline value and it was present in 21 out of 53 patients (39.6%). In our study a cutoff value of 12.16% for CAPVV with sensitivity of 85.71% and specificity of 56.25% while the cut off value of 21.58% for IJVCI with sensitivity of 71.43% and specificity 84.38% were obtained, for the prediction of post spinal hypotension.

Both IJVCI and CAPVV were found to be significantly useful for prediction of post spinal hypotension where, IJVCI assessment was found to have more specificity (84.38%), whereas CAPVV had more sensitivity (85.71%) for prediction of hypotension. Hence to conclude in terms of accuracy, which is a measure of closeness to the true value of the quantity, IJVCI was found to be a better and more accurate predictor of hypotension post spinal anaesthesia as compared to CAPVV assessment.

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KEY TO MASTER CHART

Category	Code	Inference
Sex	M	Male
	F	Female
MBS	0 1 2 3	Modified Bromage Score
		Grade 0
		Grade 1
		Grade 2
		Grade 3
Hypotension and Bradycardia (Y/N)	Y	Yes
	N	No
NKDA		No known drug allergy
WNL		Within Normal Limit
Type of Surgery	TKR	Total Knee Replacement
	#	Fracture
	ACL	Anterior Cruciate Ligament
	URS	Ureteroscopy
	URSL	Ureteroscopic Lithotripsy
	Exfix	External Fixator
	R	Right
	L	Left
	B/L	Bilateral
American Society of Anaesthesiologists	ASA 1 2 3	Grade I II III
Vitals	HR	Heart rate
	MAP	Mean Arterial Pressure
	SBP	Systolic Blood Pressure
	DBP	Diastolic Blood Pressure
	SpO2	Oxygen saturation

Sr. No	MRD. No	Name	Date of surgery	Age	Sex	ASA Grade	Weight (Kg)	Height (cm)	BMI (Kg/m2)	Drug allergy	Relevant History	Diagnosis	Surgery Performed	Relevant Investigations	Cns Examination	Chest Examination	CVS Examination	Other System	Max. Carotid Peak velocity
1	1370328	SS	11/8/2022	37	M	2	52	160	20.31	NKDA	-	R Varicose Vein	R Vein ligation	-	WNL	WNL	WNL	WNL	13.6
2	1414992	JS	11/16/2022	38	M	2	121	183	36.13	NKDA	-	Fistula in ano	Fistula Extension	-	WNL	WNL	WNL	WNL	16.65
3	1415929	NS	11/21/2022	31	M	1	67	170	23.18	NKDA	-	Perianal Fistula	Fistulectomy	-	WNL	WNL	WNL	WNL	16.6
4	1400076	MS	11/29/2022	60	M	3	90	168	31.89	NKDA	-	Cellulitis R Leg	Fasciotomy	-	WNL	WNL	WNL	WNL	16.4
5	1423427	KS	11/30/2022	43	M	3	90	180	27.78	NKDA	-	R Meniscus Tear	Arthroscopoic Debridement	-	WNL	WNL	WNL	WNL	16.6
6	1414111	AJ	12/17/2022	32	M	1	82	170	28.37	NKDA	-	R ACL Tear	R ACL Reconstruction	-	WNL	WNL	WNL	WNL	16.35
7	1419866	AP	12/17/2022	43	M	3	102	175	33.31	NKDA	-	Wound Excision Leg	Suturing	-	WNL	WNL	WNL	WNL	23.4
8	1433760	BR	12/23/2022	60	M	2	50	165	18.37	NKDA	-	R L Limb Crush	Above Knee Amputation	-	WNL	WNL	WNL	WNL	22.2
9	1423874	P	12/24/2022	76	F	2	42	152	18.18	NKDA	-	R Femur #	Femur shaft Plating	-	WNL	WNL	WNL	WNL	20
10	1400342	RS	12/27/2022	22	M	2	65	168	23.03	NKDA	-	L Femur #	L Femur Nailing	-	WNL	WNL	WNL	WNL	16.1
11	1438312	KS	12/28/2022	33	M	2	75	165	27.55	NKDA	-	R Tibia #	R Tibia Plating	-	WNL	WNL	WNL	WNL	18.45
12	1251486	BS	12/29/2022	38	F	1	85	172	28.73	NKDA	-	BImalleolar Ankle #	L Sequestrectomy Ankle	-	WNL	WNL	WNL	WNL	15.4
13	1435992	PK	12/30/2022	52	M	2	64	162	24.39	NKDA	-	R Septic Knee	Arthroscopoic knee lavage	-	WNL	WNL	WNL	WNL	11.85
14	524105	GS	2/18/2023	47	M	2	57	165	20.94	NKDA	-	Bimalleolar #	Bimalleolar Repair	-	WNL	WNL	WNL	WNL	13.45
15	1473518	GS	3/3/2023	37	M	1	84	175	27.43	NKDA	-	L Femur #	L Femur Nailing	-	WNL	WNL	WNL	WNL	18.8
16	1336883	SK	3/6/2023	52	M	3	100	188	28.29	NKDA	-	Bony Protusion L Foot	Escision	-	WNL	WNL	WNL	WNL	28.85
18	1476910	HK	3/9/2023	34	F	2	74	160	28.91	NKDA	-	R Tibia #	R Tibia Plating	-	WNL	WNL	WNL	WNL	21.2
20	40180	RK	3/28/2023	51	F	2	60	160	23.44	NKDA	-	TKR	B/L TKR	-	WNL	WNL	WNL	WNL	16.1
21	1491256	RB	4/2/2023	54	M	1	70	168	24.80	NKDA	-	L Foot Ulcer	Skin Grafting	-	WNL	WNL	WNL	WNL	23.15
22	1499511	MS	4/17/2023	33	M	2	104	176	33.57	NKDA	-	Perianal Fistula	Fistulectomy	-	WNL	WNL	WNL	WNL	13.6
23	1503588	S	4/22/2023	28	M	1	87	173	29.07	NKDA	-	Perianal Fistula	Fistulectomy	-	WNL	WNL	WNL	WNL	17.85
24	1494883	MR	5/2/2023	65	M	2	96	168	34.01	NKDA	-	Bladder Stone	Cystolithopexy	-	WNL	WNL	WNL	WNL	13.65
25	1511541	KS	5/6/2023	42	M	2	119	183	35.53	NKDA	-	L Uretric Calculus	URS	-	WNL	WNL	WNL	WNL	16.95
26	1509236	SR	5/8/2023	39	M	2	75	175	24.49	NKDA	-	R Femur #	Wound Debridment	-	WNL	WNL	WNL	WNL	28.15
27	481168	BB	5/9/2023	25	M	1	69	180	21.30	NKDA	-	R Uretric Calculus	R URSL	-	WNL	WNL	WNL	WNL	23.9
28	1280648	MA	5/9/2023	24	M	1	60	158	24.03	NKDA	-	Hydrocoele	Hydrocoele Repair	-	WNL	WNL	WNL	WNL	23.9
29	1351130	GS	5/11/2023	58	M	2	81	173	27.06	NKDA	-	L Renal Calculi	L URS	-	WNL	WNL	WNL	WNL	15.3
30	1520272	DK	5/20/2023	23	M	1	70	170	24.22	NKDA	-	Testicular Swelling	Hydrocoele Repair	-	WNL	WNL	WNL	WNL	13.35
31	1510521	IS	5/26/2023	35	M	2	80	173	26.73	NKDA	-	R Heel Trauma	Debridement	-	WNL	WNL	WNL	WNL	17.2
32	1521698	MK	5/26/2023	68	F	2	95	165	34.89	NKDA	-	Cystocoele	Cystocoele Repair	-	WNL	WNL	WNL	WNL	12.5
33	1515665	JS	5/31/2023	76	M	2	76	175	24.82	NKDA	-	SCC Penile Growth	Pencetomy	-	WNL	WNL	WNL	WNL	13.55
34	1503133	NS	6/5/2023	74	F	1	74	158	29.64	Tetracycline	-	R Tumour Foot	R Below Knee Amputation	-	WNL	WNL	WNL	WNL	11.1
35	1531681	SS	6/8/2023	60	M	2	70	168	24.80	NKDA	-	L Leg #	L Leg Exfix	-	WNL	WNL	WNL	WNL	14.7
36	1531195	CP	6/9/2023	55	M	3	52	163	19.57	NKDA	-	R Diabetic Foot	Debridement	-	WNL	WNL	WNL	WNL	16.75
37	1210983	S	6/15/2023	35	F	2	64	170	22.15	NKDA	-	Vaginal Cyst	Vaginal Cyst Excision	-	WNL	WNL	WNL	WNL	29.85
38	1600213	RJ	10/2/2023	60	F	1	67	158	26.84	NKDA	-	L Tibia #	L Tibia Exfix	-	WNL	WNL	WNL	WNL	15.4
39	1600231	GK	10/3/2023	50	F	1	73	160	28.52	NKDA	-	L Ankle #	Ankle Reduction K Wire	-	WNL	WNL	WNL	WNL	21.85
40	1605026	DS	10/10/2023	59	M	2	115	191	31.52	NKDA	-	L Tibia #	L Tibia Exfix	-	WNL	WNL	WNL	WNL	19.15
41	1607829	GS	10/14/2023	50	M	2	61	170	21.11	NKDA	-	R Tibia #	R Tibia Exfix	-	WNL	WNL	WNL	WNL	24.45
42	1608300	SS	10/15/2023	44	M	1	60	163	22.58	NKDA	-	R Tibia #	R Tibia Exfix	-	WNL	WNL	WNL	WNL	19.25
43	1042399	MS	10/20/2023	18	M	1	94	183	28.07	NKDA	-	Femur Nail	Femur Nail Removal	-	WNL	WNL	WNL	WNL	10.07
44	1612430	NS	10/23/2023	51	M	2	70	170	24.22	NKDA	-	L Diabetic Foot	Below Knee Amputation	-	WNL	WNL	WNL	WNL	29.5
45	1613711	PM	10/25/2023	28	M	1	70	170	24.22	NKDA	-	Degloving Injury	Genatalia Reconstruction	-	WNL	WNL	WNL	WNL	23.3
46	1625493	BC	11/21/2023	28	F	1	60	160	23.44	NKDA	-	R ACL Tear	ACL Repair	-	WNL	WNL	WNL	WNL	15.2
47	1631127	AS	12/1/2023	47	M	1	76	173	25.39	NKDA	-	Perianal Fistula	Fistulectomy	-	WNL	WNL	WNL	WNL	26.95
48	1631993	HP	12/2/2023	20	M	1	52	168	18.42	NKDA	-	Hemorrhoid	Hemorrhoidectomy	-	WNL	WNL	WNL	WNL	27.75
49	1578062	RK	12/4/2023	46	F	2	65	160	25.39	NKDA	-	Raw Wound Leg L	Skin Grafting L Leg	-	WNL	WNL	WNL	WNL	12.15
50	1553806	VS	12/5/2023	24	M	1	62	168	21.97	NKDA	-	Perianal Fistula	Fistulectomy	-	WNL	WNL	WNL	WNL	23.75
51	1631117	JG	12/6/2023	29	M	1	72	178	22.72	NKDA	-	Perianal Fistula	Fistulectomy	-	WNL	WNL	WNL	WNL	13.3
52	389832	BS	12/6/2023	46	M	2	104	180	32.10	NKDA	-	R Varicose Vein	Varicose Vein Ligation	-	WNL	WNL	WNL	WNL	14.65
53	1524866	RK	12/7/2023	37	F	3	88	163	33.12	NKDA	-	L Varicose Vein	Varicose Vein Ligation	-	WNL	WNL	WNL	WNL	15.15
55	117065	RS	12/14/2023	47	M	2	65	172	21.97	NKDA	-	Perianal Fistula	Fistulectomy	-	WNL	WNL	WNL	WNL	17.8
56	1638622	BS	12/15/2023	45	M	1	73	170	25.26	NKDA	-	L Varicose Vein	Varicose Vein Ligation	-	WNL	WNL	WNL	WNL	16.5

Sr. No	MRD. No	Min. Carotid Peak velocity	Mean Carotid Peak Velocity	Peak velocity Index %	Hypotension episode	IJV _Maximum diameter (mm)	IJV _Minimum diameter (mm)	IJV Collapsibility index %	Highest level of sensory block achieved	0 Minute	5 Minute	10 Minute	15 Minute	20 Minute	25 Minute	30 Minute	Time taken to achieve highest level of sensory block (MINS)	Highest degree of motor block achieved	0 Minute
1	1370328	12.55	13.08	8.02	N	0.88	0.64	27.27	T10	0	T12	T11	T10	T10	T10	T10	-	MBS 3	0
2	1414992	11	13.8	41	Y	0.66	0.49	26.5	T7	0	T10	T7	T7	T7	T7	T7	-	MBS 3	0
3	1415929	15.3	16.95	8.15	N	0.66	0.54	18.75	T7	0	T11	T10	T9	T7	T7	T7	-	MBS 3	0
4	1400076	14.35	15.37	13.66	N	0.94	0.84	10.63	T4	0	T10	T5	T4	T4	T4	T4	-	MBS 3	0
5	1423427	16.1	16.35	3.05	N	1.37	1.22	10.94	T6	0	T11	T10	T6	T6	T6	T6	-	MBS 3	0
6	1414111	14.75	15.55	10.29	N	1.36	1.08	20.49	T9	0	T12	T10	T9	T9	T9	T9	-	MBS 3	0
7	1419866	20.25	21.8	14.45	Y	0.72	0.48	33.3	T3	0	T8	T4	T3	T3	T3	T4	-	MBS 3	0
8	1433760	19.3	20.73	14	Y	0.87	0.67	23.6	T5	0	T11	T10	T6	T5	T5	T5	-	MBS 3	0
9	1423874	17.9	18.95	11.08	Y	0.35	0.19	45	T5	0	T10	T6	T5	T5	T5	T5	-	MBS 3	0
10	1400342	14.2	15.15	12.54	Y	0.48	0.33	31.25	T7	0	T11	T10	T8	T7	T7	T7	-	MBS 3	0
11	1438312	17.2	17.82	7.01	N	0.59	0.48	18.6	T8	0	T12	T12	T10	T9	T8	T8	-	MBS 3	0
12	1251486	13.6	14.5	12.4	Y	0.85	0.63	25.88	T4	0	T10	T6	T5	T4	T4	T4	-	MBS 3	0
13	1435992	10.3	11.07	14	N	0.66	0.47	28.35	T6	0	T12	T10	T10	T10	T8	T6	-	MBS 3	0
14	524105	11.8	12.63	13.5	Y	1.05	0.78	25.7	T6	0	T11	T9	T7	T6	T6	T6	-	MBS 3	0
15	1473518	17.05	18	9.2	Y	0.62	0.4	35	T7	0	T11	T9	T7	T7	T7	T7	-	MBS 3	0
16	1336883	25.8	27.32	11.14	N	0.88	0.75	14.75	T7	0	T10	T8	T7	T7	T7	T7	-	MBS 3	0
18	1476910	18.6	19.85	13.29	Y	0.85	0.71	16	T7	0	T11	T9	T8	T7	T8	T9	-	MBS 3	0
20	40180	13.4	15.05	14.22	N	0.55	0.48	12.02	T7	0	T10	T9	T7	T7	T7	T7	-	MBS 3	0
21	1491256	19.7	21.5	15.84	N	0.81	0.67	17.79	T7	0	T10	T7	T7	T7	T7	T7	-	MBS 3	0
22	1499511	11.55	12.58	16.6	Y	0.78	0.59	25.45	T6	0	T10	T7	T6	T6	T6	T6	-	MBS 3	0
23	1503588	14.2	16.02	22.94	Y	0.71	0.55	21.95	T6	0	T11	T9	T7	T6	T6	T6	-	MBS 3	0
24	1494883	12.3	12.95	10.76	N	1.59	1.39	12.34	T6	0	T11	T6	T6	T6	T6	T6	-	MBS 3	0
25	1511541	13.5	15.22	22.66	Y	1.18	0.87	25.94	T5	0	T10	T5	T5	T5	T5	T5	-	MBS 3	0
26	1509236	24.5	26.2	13.94	N	1.18	1	14.84	T6	0	T8	T6	T6	T6	T6	T6	-	MBS 3	0
27	481168	21.2	22.55	11.88	N	0.79	0.71	10.03	T8	0	T10	T9	T8	T8	T8	T8	-	MBS 3	0
28	1280648	22.5	23.18	6.3	N	0.59	0.46	21.13	T5	0	T7	T5	T5	T5	T5	T5	-	MBS 3	0
29	1351130	14.3	14.8	6.4	N	0.55	0.47	13.6	T6	0	T10	T8	T6	T6	T6	T6	-	MBS 3	0
30	1520272	10.2	11.78	26.75	N	1.01	0.89	12.4	T5	0	T10	T6	T5	T5	T5	T5	-	MBS 3	0
31	1510521	14.1	15.65	19.8	Y	0.93	0.71	23.65	T4	0	T10	T10	T6	T4	T4	T4	-	MBS 3	0
32	1521698	11.2	11.85	10.1	Y	1.36	1.19	12.82	T5	0	T8	T6	T5	T5	T5	T5	-	MBS 3	0
33	1515665	10.26	11.88	27.31	Y	0.68	0.55	18.51	T10	0	T12	T11	T10	T10	T10	T10	-	MBS 3	0
34	1503133	9.75	10.5	6.93	N	0.7	0.46	33.62	T7	0	T10	T8	T7	T7	T7	T7	-	MBS 3	0
35	1531681	11.7	13.2	22.58	Y	1.16	0.61	47.18	T5	0	T8	T6	T5	T5	T5	T5	-	MBS 3	0
36	1531195	14.05	15.4	17.5	N	1.54	1.47	4.54	T4	0	T8	T5	T4	T4	T4	T4	-	MBS 3	0
37	1210983	27.3	28.57	8.94	N	0.83	0.65	21.21	T7	0	T12	T10	T8	T7	T7	T7	-	MBS 3	0
38	1600213	12.5	13.95	20.89	Y	0.62	0.47	24.19	T7	0	T11	T10	T7	T8	T9	T7	-	MBS 3	0
39	1600231	19.35	20.6	11.91	N	1.25	1.05	16.02	T8	0	T10	T9	T8	T8	T8	T8	-	MBS 3	0
40	1605026	16.85	18	12.69	N	1.38	1.05	23.94	T8	0	T12	T11	T10	T8	T8	T8	-	MBS 3	0
41	1607829	23	23.73	6.15	N	0.78	0.66	15.41	T8	0	T11	T8	T8	T8	T8	T8	-	MBS 3	0
42	1608300	16.95	18.1	12.67	Y	0.6	0.5	15.66	T7	0	T11	T8	T7	T7	T7	T7	-	MBS 3	0
43	1042399	8.49	9.28	17.22	Y	1.12	0.97	13.37	T7	0	T8	T7	T7	T7	T7	T7	-	MBS 3	0
44	1612430	24.2	26.8	19.35	N	1.5	1.28	14.62	T7	0	T10	T8	T7	T7	T7	T7	-	MBS 3	0
45	1613711	21.7	22.3	6.05	N	1.37	1.25	9.08	T8	0	T10	T8	T8	T8	T8	T8	-	MBS 3	0
46	1625493	13.5	14.3	11.9	N	0.59	0.52	12.68	T7	0	T10	T8	T7	T7	T7	T7	-	MBS 3	0
47	1631127	24.7	25.82	8.66	N	1.29	1.21	6.58	T8	0	T10	T8	T8	T8	T8	T8	-	MBS 3	0
48	1631993	22.3	25.02	21.16	Y	1.3	1.01	22.14	T5	0	T5	T8	T6	T5	T5	T5	-	MBS 3	0
49	1578062	9.19	10.65	27.7	Y	0.81	0.74	8.65	T6	0	T10	T8	T6	T6	T6	T6	-	MBS 3	0
50	1553806	20.8	22.27	13.22	N	0.85	0.8	6.45	T7	0	T8	T7	T7	T7	T7	T7	-	MBS 3	0
51	1631117	11	12.18	19.33	N	0.9	0.75	16.64	T7	0	T8	T7	T7	T7	T7	T7	-	MBS 3	0
52	389832	12.85	13.75	13.06	N	1.17	1	13.73	T8	0	T10	T8	T8	T8	T8	T8	-	MBS 3	0
53	1524866	13.6	14.4	10.89	N	0.89	0.76	14.54	T8	0	T10	T8	T8	T8	T8	T8	-	MBS 3	0
55	117065	14.1	15.9	23.27	N	0.9	0.74	16.72	T8	0	T10	T8	T8	T8	T8	T8	-	MBS 3	0
56	1638622	14	15.3	16.15	N	0.56	0.41	26.79	T7	0	T10	T7	T8	T9	T10	T7	-	MBS 3	0

Sr. No	MRD. No	5 Minute	10 Minute	15 Minute	20 Minute	25 Minute	30 Minute	Time taken to achieve highest degree of motor block (MINS)	HR_ Baseline	HR_0 Minute	HR_2 Minute	HR_4 Minute	HR_6 Minute	HR_8 Minute	HR_10 Minute	HR_12 Minute	HR_14 Minute	HR_16 Minute	HR_18 Minute	HR_20 Minute	HR_22 Minute
1	1370328	MBS 1	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	64	64	68	62	68	64	66	64	62	66	68	60	62
2	1414992	MBS 1	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	-	73	74	72	74	79	74	68	72	66	62	64	70	68
3	1415929	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	90	98	92	96	94	94	92	90	96	100	94	92	96
4	1400076	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	93	96	92	86	88	84	84	82	84	80	82	80	86
5	1423427	MBS 1	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	-	77	78	78	82	82	80	76	76	80	72	74	76	80
6	1414111	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	79	78	76	74	78	76	74	78	76	79	74	76	72
7	1419866	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	104	102	100	102	100	106	94	86	82	88	84	80	86
8	1433760	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	92	90	92	90	94	88	96	94	98	92	99	94	98
9	1423874	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	69	70	68	66	66	64	60	62	64	63	66	64	68
10	1400342	MBS 1	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	-	106	102	104	106	101	98	102	114	120	124	118	114	108
11	1438312	MBS 0	MBS 1	MBS 2	MBS 3	MBS 3	MBS 3	-	95	94	96	90	92	91	92	90	88	94	96	98	94
12	1251486	MBS 1	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	95	94	92	90	90	89	88	89	86	84	86	88	92
13	1435992	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	69	68	72	74	70	72	74	70	67	66	65	64	64
14	524105	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	106	104	108	110	109	106	108	104	98	106	100	98	96
15	1473518	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	93	96	94	98	92	92	90	92	84	76	73	76	80
16	1336883	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	90	90	84	84	82	83	88	85	84	85	84	85	86
18	1476910	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	81	80	82	84	84	80	86	88	90	86	84	82	86
20	40180	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	91	90	90	94	91	90	88	88	92	94	96	96	98
21	1491256	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	118	126	124	120	118	117	116	110	108	104	102	96	98
22	1499511	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	89	90	88	86	84	85	82	80	79	80	76	78	76
23	1503588	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	89	90	88	86	80	74	74	72	68	74	75	70	72
24	1494883	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	65	62	63	66	64	65	65	64	66	68	62	62	61
25	1511541	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	110	110	110	110	110	108	107	104	103	102	100	98	96
26	1509236	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	89	94	92	90	92	88	85	86	88	90	94	89	90
27	481168	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	75	76	74	70	72	71	70	70	68	74	76	77	70
28	1280648	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	70	67	68	66	64	66	62	61	68	66	64	67	62
29	1351130	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	87	88	82	80	80	78	76	73	70	68	72	75	76
30	1520272	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	80	82	84	80	78	76	74	74	70	68	70	72	74
31	1510521	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	93	94	96	88	86	86	82	78	74	76	70	64	66
32	1521698	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	68	69	72	76	74	72	76	70	68	68	63	66	62
33	1515665	MBS 1	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	-	112	116	110	108	109	106	107	110	111	102	104	106	102
34	1503133	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	80	82	80	76	78	75	72	74	76	74	72	70	70
35	1531681	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	78	80	78	76	74	72	70	70	66	64	62	66	66
36	1531195	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	73	74	72	70	68	72	70	66	64	62	62	66	68
37	1210983	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	77	76	77	74	72	70	71	73	70	72	68	67	70
38	1600213	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	81	82	80	76	78	72	76	70	68	68	72	70	72
39	1600231	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	103	108	102	106	98	96	96	97	94	92	90	91	92
40	1605026	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	89	90	88	84	82	80	76	74	76	75	80	77	76
41	1607829	MBS 2	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	-	87	88	84	80	78	76	74	72	70	72	76	78	74
42	1608300	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	132	132	130	128	124	118	120	116	114	110	109	108	110
43	1042399	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	75	74	64	66	68	70	68	66	62	64	66	68	68
44	1612430	MBS2	MBS3	MBS3	MBS3	MBS3	MBS3	-	96	98	96	96	94	92	92	90	84	86	87	88	90
45	1613711	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	77	76	74	72	72	70	70	68	70	68	66	70	68
46	1625493	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	77	78	74	72	72	71	69	70	66	68	66	67	69
47	1631127	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	84	86	84	82	82	78	79	80	76	76	77	78	80
48	1631993	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	87	88	84	82	78	74	72	70	68	66	64	66	68
49	1578062	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	113	114	114	118	120	122	116	110	108	106	104	100	98
50	1553806	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	96	96	97	98	95	96	96	94	92	90	91	90	92
51	1631117	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	97	98	99	101	96	94	94	96	96	95	92	93	94
52	389832	MBS 2	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	78	79	78	76	76	77	78	75	76	75	75	76	74
53	1524866	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	77	78	78	76	77	76	76	75	75	77	74	74	72
55	117065	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	74	74	75	74	72	71	71	70	69	68	66	67	67
56	1638622	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	MBS 3	-	77	78	76	75	74	70	72	72	70	71	67	68	70

Sr. No	MRD. No	HR_24 Minute	HR_26 Minute	HR_28 Minute	HR_30 Minute	HR_40 Minute	HR_50 Minute	HR_60 Minute	SBP_Baseline	SBP_0 Minute	SBP_2 Minute	SBP_4 Minute	SBP_6 Minute	SBP_8 Minute	SBP_10 Minute	SBP_12 Minute	SBP_14 Minute	SBP_16 Minute	SBP_18 Minute	SBP_20 Minute	SBP_22 Minute	SBP_24 Minute
1	1370328	66	64	68	64	62	60	64	133	134	346	132	132	130	130	126	126	124	126	124	120	119
2	1414992	66	68	70	74	68	66	70	125	124	124	120	112	110	102	100	96	94	102	114	110	111
3	1415929	94	93	93	90	92	90	92	132	134	130	132	128	128	122	124	120	116	118	113	116	114
4	1400076	82	84	80	82	84	78	82	128	130	126	118	116	116	110	106	108	108	106	110	116	114
5	1423427	68	70	66	70	66	62	68	168	166	164	160	162	158	155	160	152	154	152	150	148	150
6	1414111	72	70	68	69	66	70	68	133	130	128	124	126	124	125	128	122	119	120	122	120	124
7	1419866	88	86	90	84	90	92	88	158	152	146	140	132	126	113	116	110	103	105	106	102	108
8	1433760	98	100	101	102	96	104	104	135	136	130	120	110	108	104	106	102	107	116	109	110	102
9	1423874	69	66	67	63	65	62	64	195	200	190	184	170	164	141	134	133	138	136	140	140	137
10	1400342	106	104	110	108	106	102	99	137	138	136	130	126	124	120	118	118	116	110	112	114	112
11	1438312	92	90	90	86	85	86	92	115	116	114	111	110	114	108	110	111	112	110	108	106	107
12	1251486	90	87	84	80	86	84	82	151	150	152	140	128	116	116	109	110	10	110	111	108	114
13	1435992	64	64	64	65	62	64	64	124	122	114	112	110	114	112	115	114	112	115	114	113	112
14	524105	94	93	96	99	101	104	102	174	170	162	154	148	142	140	136	132	120	112	111	108	105
15	1473518	83	82	86	82	80	78	84	139	134	130	126	128	128	124	122	110	95	101	112	114	112
16	1336883	89	84	80	82	78	79	80	138	140	137	130	128	123	120	117	123	120	124	125	124	128
18	1476910	82	84	82	80	80	82	82	131	130	120	118	116	108	103	94	100	104	102	100	98	106
20	40180	92	94	94	96	92	96	90	153	150	148	150	144	138	134	130	132	130	126	128	130	132
21	1491256	98	100	96	96	94	96	98	157	154	140	137	138	140	142	138	140	136	137	138	136	140
22	1499511	78	80	80	76	81	82	84	133	136	134	134	130	126	116	112	108	102	100	98	103	110
23	1503588	70	71	75	73	76	77	78	128	130	126	120	112	110	110	106	102	108	110	117	118	114
24	1494883	65	63	62	64	66	68	66	160	160	156	150	148	146	146	142	140	134	130	132	130	134
25	1511541	96	98	94	96	94	98	94	155	156	155	156	154	154	150	135	140	142	140	140	134	122
26	1509236	92	90	87	88	90	86	80	122	123	121	114	111	101	104	105	107	108	106	110	106	108
27	481168	68	66	69	70	74	74	76	116	118	116	112	114	116	110	104	106	110	112	108	111	110
28	1280648	64	66	63	64	62	64	66	117	118	116	114	110	108	106	102	100	97	96	100	101	107
29	1351130	80	82	83	82	86	84	84	144	142	138	136	132	128	126	124	120	122	124	127	130	131
30	1520272	75	74	76	76	74	72	72	134	136	134	126	124	118	114	112	114	110	112	116	111	115
31	1510521	68	74	76	78	80	81	78	150	150	150	148	142	134	130	128	112	108	100	90	120	118
32	1521698	68	64	66	68	64	66	68	159	158	156	150	146	146	142	140	134	125	121	130	122	124
33	1515665	100	104	104	100	102	106	102	168	170	164	166	170	143	128	130	120	109	117	110	114	109
34	1503133	68	70	68	66	62	64	62	135	134	132	130	130	124	128	126	126	128	126	120	121	118
35	1531681	68	66	68	70	74	74	75	157	160	158	146	142	140	137	136	130	124	120	126	130	135
36	1531195	68	70	70	72	71	74	76	175	176	170	165	164	160	150	144	146	142	146	150	152	148
37	1210983	69	71	70	68	72	74	76	133	134	130	128	122	120	118	116	112	118	120	121	120	118
38	1600213	71	70	74	76	77	75	74	133	134	130	126	126	114	110	102	106	112	114	116	118	117
39	1600231	94	96	98	94	96	92	94	137	138	130	127	125	126	124	118	116	119	120	119	124	125
40	1605026	78	78	80	82	82	84	85	141	142	140	138	134	128	120	118	119	121	124	126	128	128
41	1607829	76	76	78	80	76	76	74	130	132	126	126	124	118	114	112	108	110	112	114	116	120
42	1608300	112	114	116	118	120	122	124	141	142	140	137	130	128	124	118	114	110	105	101	112	114
43	1042399	66	68	70	68	70	68	70	136	135	130	126	120	114	102	100	96	98	102	110	112	114
44	1612430	88	88	90	90	86	88	90	141	142	140	130	128	126	124	120	118	115	120	122	126	128
45	1613711	70	72	68	70	70	68	66	125	126	120	118	116	118	114	112	110	108	110	112	114	116
46	1625493	72	70	68	70	71	73	70	124	126	124	124	120	119	116	116	112	114	116	118	114	115
47	1631127	78	76	74	76	77	76	74	137	136	136	132	128	124	124	120	116	118	120	122	124	124
48	1631993	67	68	72	72	69	70	71	123	124	120	116	114	112	108	106	100	96	92	94	102	110
49	1578062	100	101	104	108	110	112	110	157	158	152	150	142	134	126	112	105	110	112	114	118	120
50	1553806	88	89	92	94	96	99	97	125	126	125	120	118	116	114	115	112	108	109	110	112	114
51	1631117	92	96	97	97	98	94	96	145	146	140	138	137	132	130	128	126	126	121	122	124	126
52	389832	73	74	74	76	75	76	77	142	142	140	138	138	134	136	136	132	132	130	128	132	128
53	1524866	70	68	70	71	72	74	74	125	126	124	124	124	123	122	121	120	118	116	114	112	114
55	117065	67	66	68	68	68	67	66	133	134	130	128	126	125	124	120	112	114	114	116	118	124
56	1638622	71	72	72	74	73	74	75	125	126	124	118	116	118	115	112	112	110	109	112	114	115

Sr. No	MRD. No	SBP_26 Minute	SBP_28 Minute	SBP_30 Minute	SBP_40 Minute	SBP_50 Minute	SBP_60 Minute	DBP_Baseline	DBP_0 Minute	DBP_2 Minute	DBP_4 Minute	DBP_6 Minute	DBP_8 Minute	DBP_10 Minute	DBP_12 Minute	DBP_14 Minute	DBP_16 Minute	DBP_18 Minute	DBP_20 Minute	DBP_22 Minute	DBP_24 Minute	DBP_26 Minute
1	1370328	123	125	119	120	124	128	85	86	88	84	82	78	80	82	80	83	82	80	80	76	82
2	1414992	112	108	110	106	108	114	87	86	86	82	78	74	72	67	60	58	62	68	70	72	68
3	1415929	120	111	112	114	118	116	81	80	80	76	74	76	72	72	70	68	70	66	68	70	72
4	1400076	110	109	116	114	110	118	83	84	80	80	74	72	70	66	70	68	72	70	74	72	70
5	1423427	148	146	146	145	145	148	103	100	102	104	100	98	98	102	96	98	94	92	92	90	92
6	1414111	124	126	124	120	124	126	88	90	88	82	80	80	82	78	78	76	76	72	78	74	76
7	1419866	110	111	108	114	110	118	122	96	88	82	76	48	64	76	70	60	60	64	66	60	60
8	1433760	100	107	116	118	110	109	80	80	81	80	76	74	70	70	66	72	80	78	76	74	72
9	1423874	135	138	137	140	136	132	86	86	86	82	74	65	72	63	64	68	68	70	68	67	68
10	1400342	108	105	116	120	124	121	85	88	82	80	78	80	76	70	68	60	64	60	62	70	70
11	1438312	111	110	112	109	112	110	61	62	60	58	59	60	58	60	62	62	60	54	56	58	60
12	1251486	120	122	124	128	130	126	87	84	86	85	78	74	70	70	72	68	70	70	68	72	76
13	1435992	117	111	115	114	112	110	79	78	74	64	65	68	70	70	68	68	66	69	68	66	69
14	524105	104	116	120	126	122	124	129	128	120	116	108	106	102	100	98	85	83	82	80	75	74
15	1473518	116	118	124	126	122	124	97	90	87	88	90	90	88	84	76	59	62	72	76	69	72
16	1336883	132	126	125	122	116	116	88	86	95	90	88	85	80	80	78	80	82	84	82	84	84
18	1476910	110	114	120	124	120	119	87	82	80	74	76	74	72	60	62	64	66	58	58	62	78
20	40180	130	128	134	140	142	140	93	90	88	88	86	86	85	82	82	80	79	82	84	86	84
21	1491256	138	132	130	132	134	136	81	82	84	84	86	90	91	90	90	88	88	90	86	90	88
22	1499511	112	124	128	130	132	134	93	94	92	90	90	88	86	80	74	70	68	68	70	72	74
23	1503588	110	111	112	114	116	116	88	84	68	66	62	68	70	62	58	60	64	67	68	64	68
24	1494883	136	138	136	140	140	142	83	84	80	80	78	76	74	71	70	70	69	70	68	70	72
25	1511541	109	102	108	118	126	130	95	92	94	92	92	90	90	80	83	82	80	80	80	74	68
26	1509236	102	108	110	112	110	114	86	88	87	78	70	68	65	67	66	71	68	69	70	65	65
27	481168	105	112	106	108	114	116	76	77	76	72	74	70	68	67	66	70	70	68	70	70	70
28	1280648	110	108	112	111	114	116	66	68	67	65	64	64	62	60	60	56	56	58	60	62	62
29	1351130	134	135	137	138	140	141	88	88	84	81	80	78	76	76	70	72	75	78	76	76	76
30	1520272	120	118	124	122	120	122	85	86	84	80	76	74	70	69	68	66	66	69	67	66	70
31	1510521	111	116	124	140	142	138	91	92	90	82	80	78	74	68	64	56	54	50	70	68	63
32	1521698	115	140	134	128	120	124	87	91	88	90	85	85	84	82	80	80	77	82	78	81	71
33	1515665	117	118	114	114	126	125	93	95	97	92	94	86	84	78	65	64	62	62	62	62	62
34	1503133	120	118	118	117	115	118	80	80	80	79	78	74	78	75	74	76	74	74	76	78	76
35	1531681	134	138	140	136	138	138	93	94	92	84	86	80	78	74	72	64	62	66	70	70	70
36	1531195	144	150	151	152	154	156	89	90	86	86	82	81	80	78	76	76	72	76	78	76	74
37	1210983	124	126	125	128	126	124	81	82	80	76	72	72	70	70	68	70	70	72	70	70	71
38	1600213	121	122	120	128	126	130	78	78	78	76	72	68	60	58	64	66	66	64	68	70	68
39	1600231	124	122	126	128	126	129	99	98	92	84	85	82	78	76	74	76	78	78	84	83	86
40	1605026	134	132	130	128	134	134	77	78	76	74	74	72	70	66	68	68	70	70	72	71	71
41	1607829	124	126	124	122	120	121	77	78	72	70	70	70	68	70	67	68	66	68	68	70	72
42	1608300	120	118	124	126	130	136	98	98	94	82	80	78	78	76	72	70	67	64	68	72	74
43	1042399	114	116	118	120	122	124	67	66	68	62	60	58	52	50	40	42	46	48	50	52	52
44	1612430	130	128	132	130	132	130	76	76	76	72	70	70	68	70	68	70	72	74	76	78	74
45	1613711	118	118	114	112	118	120	73	74	72	70	68	70	71	70	70	71	72	74	74	76	74
46	1625493	118	120	119	116	118	120	75	76	76	72	70	68	66	64	64	66	68	70	68	69	70
47	1631127	128	127	128	130	130	128	95	96	94	90	90	88	88	86	84	85	86	88	88	87	90
48	1631993	112	116	120	118	118	117	76	76	70	68	64	64	60	60	58	54	52	52	54	58	60
49	1578062	122	120	126	128	126	126	107	108	100	98	86	80	74	70	66	70	70	72	72	74	76
50	1553806	116	118	117	118	120	122	71	72	71	70	68	66	66	67	68	67	66	68	68	69	70
51	1631117	126	126	128	126	124	126	88	89	87	87	85	85	84	82	82	82	81	80	80	81	82
52	389832	126	128	126	127	128	128	80	80	80	81	80	80	80	80	81	80	81	80	80	81	80
53	1524866	114	118	118	119	120	121	69	70	70	69	69	67	67	67	67	68	67	66	65	66	67
55	117065	124	124	126	124	126	128	78	78	76	74	74	72	70	70	68	70	70	70	70	72	71
56	1638622	119	118	122	121	120	124	76	76	74	72	72	71	70	70	70	68	68	68	68	70	70

Sr. No	MRD. No	DBP_28 Minute	DBP_30 Minute	DBP_40 Minute	DBP_50 Minute	DBP_60 Minute	MAP_Baseline	MAP_0 Minute	MAP_2 Minute	MAP_4 Minute	MAP_6 Minute	MAP_8 Minute	MAP_10 Minute	MAP_12 Minute	MAP_14 Minute	MAP_16 Minute	MAP_18 Minute	MAP_20 Minute	MAP_22 Minute	MAP_24 Minute	MAP_26 Minute
1	1370328	78	80	82	84	86	101	102	104	100	98	100	97	97	96	97	97	95	94	91	96
2	1414992	63	70	64	64	70	100	99	99	97	94	86	82	78	72	70	76	84	83	85	83
3	1415929	70	70	70	68	72	98	98	96	95	92	94	89	90	88	84	86	82	82	85	86
4	1400076	72	70	72	70	74	98	99	95	93	88	87	84	80	83	82	83	83	88	86	84
5	1423427	92	90	90	90	92	125	122	122	123	121	118	117	121	115	112	114	112	111	110	111
6	1414111	74	76	70	72	76	103	103	101	96	95	95	96	95	93	91	91	89	92	91	93
7	1419866	62	60	68	68	78	134	115	107	101	95	88	82	89	84	74	75	78	72	76	77
8	1433760	76	76	78	78	76	99	99	97	94	87	85	82	83	78	84	92	88	87	83	82
9	1423874	68	62	66	64	62	122	124	119	116	106	98	95	87	87	91	91	93	92	90	90
10	1400342	71	72	80	78	76	102	105	100	97	94	95	91	86	85	78	80	77	79	84	83
11	1438312	60	62	58	60	56	79	80	78	76	76	78	75	77	78	79	77	72	73	74	77
12	1251486	76	78	78	80	78	108	106	108	103	95	88	85	83	85	81	83	84	82	86	91
13	1435992	66	68	68	68	66	94	93	87	80	80	83	84	85	83	83	82	84	83	81	85
14	524105	82	88	84	82	80	144	142	134	128	121	118	115	112	107	97	93	93	90	95	84
15	1473518	70	78	80	80	82	111	104	101	100	102	102	100	98	88	75	78	88	88	84	88
16	1336883	82	85	80	80	79	104	104	109	103	101	98	93	92	93	93	95	97	96	97	100
18	1476910	80	86	86	78	78	101	98	93	89	89	85	82	71	75	77	78	72	71	76	88
20	40180	84	82	86	88	96	113	110	108	108	105	103	101	98	99	98	95	97	99	101	99
21	1491256	86	90	90	88	90	106	106	102	101	103	106	108	106	106	104	104	106	102	106	104
22	1499511	76	78	88	90	90	106	108	106	104	103	100	96	90	85	80	78	78	81	84	86
23	1503588	60	58	64	66	68	101	99	87	84	78	82	83	76	72	76	79	83	84	80	82
24	1494883	72	70	76	74	74	108	109	105	103	101	99	98	95	93	91	90	90	90	91	93
25	1511541	66	68	72	80	82	115	113	114	113	112	111	110	98	102	102	100	100	98	90	82
26	1509236	64	66	68	70	80	98	99	98	90	84	79	78	80	80	83	80	82	82	79	77
27	481168	72	69	70	74	76	87	91	89	85	87	85	82	79	79	83	84	81	84	83	82
28	1280648	62	64	66	66	70	83	85	84	81	79	79	77	74	73	69	69	72	74	77	78
29	1351130	78	80	82	82	84	106	106	102	99	97	95	93	92	86	88	91	94	94	94	95
30	1520272	70	74	75	70	72	102	102	100	95	92	89	84	83	83	80	81	85	81	82	86
31	1510521	66	70	80	82	78	110	110	110	104	100	96	93	88	80	73	70	63	87	85	79
32	1521698	82	80	77	83	84	111	113	110	110	105	105	103	101	98	95	92	98	93	95	85
33	1515665	70	68	70	81	80	118	120	120	116	120	105	99	95	83	79	80	78	79	78	80
34	1503133	76	74	70	74	73	98	98	98	96	95	91	95	92	91	93	91	89	91	91	91
35	1531681	72	74	70	71	72	114	116	114	105	105	100	98	95	91	84	81	86	90	92	91
36	1531195	78	79	78	78	78	118	119	114	112	109	107	103	100	99	98	97	101	103	100	97
37	1210983	72	74	76	75	74	98	99	97	93	89	88	86	85	83	86	87	87	87	86	88
38	1600213	70	72	72	74	76	97	97	95	93	90	83	76	73	78	82	82	83	85	86	86
39	1600231	85	84	81	82	84	112	111	105	98	98	97	93	90	88	90	92	92	97	97	99
40	1605026	70	74	72	74	74	98	99	97	95	94	90	88	93	85	85	88	88	90	90	92
41	1607829	74	74	72	72	72	95	96	90	88	88	86	83	84	80	82	81	83	84	86	89
42	1608300	74	76	78	78	82	112	112	109	100	96	94	93	90	86	83	80	76	83	86	89
43	1042399	54	52	58	56	60	90	89	88	83	80	76	68	67	59	59	64	68	70	72	72
44	1612430	74	74	74	76	74	98	98	97	91	89	88	86	86	85	85	88	90	92	94	93
45	1613711	72	70	72	72	74	90	91	88	86	84	86	85	84	83	83	84	86	87	89	88
46	1625493	72	72	74	72	74	92	93	92	89	87	83	83	84	81	82	84	86	83	84	86
47	1631127	88	88	88	86	86	109	109	108	104	102	100	100	97	94	95	97	99	100	100	102
48	1631993	62	62	60	60	62	91	92	87	84	81	80	76	75	72	68	65	66	69	75	77
49	1578062	74	78	78	76	75	124	125	117	115	105	98	91	84	79	83	84	86	87	96	91
50	1553806	71	69	70	70	70	89	90	89	87	85	83	82	83	83	81	80	82	83	84	85
51	1631117	84	84	82	82	84	107	108	105	104	102	100	99	97	96	96	95	94	94	95	96
52	389832	81	80	80	80	81	100	100	100	100	100	98	98	98	98	97	97	96	97	97	96
53	1524866	70	72	73	72	72	87	88	88	87	87	86	85	85	85	85	84	82	80	82	82
55	117065	72	73	72	72	72	96	97	94	92	91	90	88	87	83	85	85	85	86	89	88
56	1638622	71	72	72	72	74	92	93	91	87	87	87	85	84	84	82	81	83	83	85	86

Sr. No	MRD. No	MAP_28 Minute	MAP_30 Minute	MAP_40 Minute	MAP_50 Minute	MAP_60 Minute	SPO2_Baseline	SPO2_0 Minute	SPO2_2 Minute	SPO2_4 Minute	SPO2_6 Minute	SPO2_8 Minute	SPO2_10 Minute	SPO2_12 Minute	SPO2_14 Minute	SPO2_16 Minute	SPO2_18 Minute	SPO2_20 Minute	SPO2_22 Minute	SPO2_24 Minute	SPO2_26 Minute
1	1370328	94	94	95	98	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
2	1414992	78	83	78	78	85	100	100	99	99	98	100	100	98	98	99	100	97	97	99	99
3	1415929	84	84	86	84	87	100	100	100	100	100	100	100	99	99	100	100	100	100	98	100
4	1400076	84	85	86	84	88	98	99	98	99	97	98	98	98	97	99	99	97	96	96	98
5	1423427	110	109	110	111	111	100	100	100	99	99	100	100	99	99	100	100	99	100	100	100
6	1414111	92	92	88	90	94	100	100	99	100	100	99	99	100	100	100	99	99	100	100	100
7	1419866	77	76	83	82	91	100	100	99	100	97	99	99	100	100	97	98	100	100	99	99
8	1433760	86	89	91	89	87	100	100	100	99	98	100	99	99	100	100	98	99	100	100	99
9	1423874	91	87	90	88	85	100	100	99	99	100	99	99	100	99	99	99	100	100	99	98
10	1400342	82	86	93	93	91	100	100	100	99	100	100	100	99	99	100	99	100	100	100	100
11	1438312	76	78	75	77	74	100	100	99	99	100	98	98	97	99	99	100	100	100	99	99
12	1251486	91	93	94	97	94	100	100	100	99	99	100	98	98	99	99	100	100	100	99	99
13	1435992	82	84	84	83	82	100	100	100	99	100	100	99	99	100	100	100	99	100	100	100
14	524105	93	99	98	95	95	100	100	100	99	100	100	99	98	99	100	100	100	99	100	100
15	1473518	86	93	95	94	95	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
16	1336883	97	98	94	92	91	100	100	100	100	100	100	100	100	99	100	100	100	100	100	100
18	1476910	91	97	98	92	92	100	100	100	98	100	98	100	100	100	99	100	100	100	99	100
20	40180	98	99	104	106	110	100	100	100	100	100	100	100	98	99	100	100	100	100	99	100
21	1491256	101	103	104	103	105	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
22	1499511	92	94	102	104	105	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
23	1503588	77	76	80	82	84	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
24	1494883	94	92	97	96	96	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
25	1511541	78	81	87	95	98	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
26	1509236	78	80	83	83	91	100	100	100	100	99	99	100	100	100	99	99	99	99	99	99
27	481168	85	81	83	87	89	100	100	100	99	99	100	100	100	99	99	100	100	99	99	100
28	1280648	77	80	81	82	83	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
29	1351130	97	99	100	101	103	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
30	1520272	86	90	90	86	88	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
31	1510521	83	88	100	102	98	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
32	1521698	101	98	94	95	97	100	100	100	99	99	100	100	100	100	100	100	100	100	100	98
33	1515665	86	83	84	96	95	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
34	1503133	90	89	86	88	88	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
35	1531681	94	96	92	93	94	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
36	1531195	102	103	103	103	104	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
37	1210983	90	91	93	92	91	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
38	1600213	87	88	90	91	94	100	100	100	99	99	99	100	100	100	100	100	99	100	100	100
39	1600231	97	98	97	97	97	100	100	100	100	100	99	99	99	98	99	99	100	100	100	100
40	1605026	92	93	90	94	94	100	100	100	100	100	99	99	98	100	100	99	100	100	100	100
41	1607829	90	90	89	88	88	100	100	100	100	100	100	100	100	100	99	99	99	100	100	100
42	1608300	89	92	94	95	100	100	100	100	100	99	99	100	100	99	99	100	100	100	100	99
43	1042399	74	74	78	78	81	100	100	100	100	100	99	99	100	100	100	99	99	100	99	100
44	1612430	92	93	93	94	93	100	100	99	99	100	99	99	100	98	99	100	100	100	100	100
45	1613711	87	84	85	87	89	100	100	99	99	100	100	100	99	99	100	100	99	99	100	100
46	1625493	88	87	88	87	89	100	100	100	100	99	100	100	100	99	100	100	100	100	100	100
47	1631127	101	101	102	100	100	100	100	100	100	99	99	100	100	100	100	99	100	100	100	100
48	1631993	80	81	80	79	80	100	100	100	100	99	100	100	100	100	100	100	100	100	100	100
49	1578062	89	94	95	93	92	100	100	100	99	99	100	100	100	100	100	100	100	100	100	100
50	1553806	87	85	86	87	87	100	100	100	100	100	100	99	99	100	100	100	100	100	100	99
51	1631117	98	98	97	96	98	100	100	100	100	99	99	100	100	100	99	100	100	100	100	100
52	389832	97	96	96	96	96	100	100	100	99	99	98	99	100	99	98	98	98	99	100	98
53	1524866	86	86	88	88	88	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
55	117065	89	90	89	90	90	100	100	100	99	100	100	100	99	99	100	100	100	98	100	100
56	1638622	87	88	88	88	91	100	100	100	100	100	100	99	99	100	100	100	100	100	100	100

Sr. No	MRD. No	SPO2_28 Minute	SPO2_30 Minute	SPO2_40 Minute	SPO2_50 Minute	SPO2_60 Minute	Hypotension episode	Times Hypotension	Maximum % fall in BP	Bradycardia episode	Times Bradycardia	Maximum % fall in HR	COMPLICATION_0 Minute	COMPLICATION_2 Minute	COMPLICATION_4 Minute	COMPLICATION_6 Minute	COMPLICATION_8 Minute	COMPLICATION_10 Minute
1	1370328	100	100	99	100	100	N	0	10.5	N	-	6.25	0	0	0	0	0	0
2	1414992	100	100	100	100	100	Y	1	24.19	N	-	15.06	0	0	0	0	0	0
3	1415929	100	99	99	99	100	N	0	15.9	N	-	0.1	0	0	0	0	0	0
4	1400076	98	97	99	97	98	N	0	17	N	-	16.12	0	0	0	0	0	0
5	1423427	99	99	100	100	100	N	0	12.6	N	-	19.48	0	0	0	0	0	0
6	1414111	100	100	100	99	99	N	0	10.52	N	-	16.45	0	0	0	0	0	0
7	1419866	98	98	99	99	100	Y	2	32.8	N	-	23.07	0	0	0	0	0	1
8	1433760	98	99	99	100	100	Y	2	26.47	N	-	2.17	0	0	0	0	0	1
9	1423874	100	99	99	100	100	Y	2	33.5	N	-	15	0	0	0	0	0	1
10	1400342	100	100	100	100	100	Y	1	24	N	-	7.5	0	0	0	0	0	0
11	1438312	100	100	99	100	99	N	0	6.95	N	-	10.5	0	0	0	0	0	0
12	1251486	98	99	100	100	99	Y	2	29.3	N	-	15.8	0	0	0	0	1	0
13	1435992	100	100	100	99	100	N	0	11.29	N	-	10.1	0	0	0	0	0	0
14	524105	99	100	100	100	100	Y	2	38.8	N	-	12.26	0	0	0	0	0	0
15	1473518	100	100	100	100	100	Y	1	29.1	N	-	21.5	0	0	0	0	0	0
16	1336883	100	100	100	100	100	N	0	15.94	N	-	13.3	0	0	0	0	0	0
18	1476910	100	100	100	100	100	Y	2	27.7	N	-	1.23	0	0	0	0	0	1
20	40180	100	100	100	100	100	N	0	17.64	N	-	3.29	0	0	0	0	0	0
21	1491256	100	100	100	100	100	N	0	17.19	N	-	20.3	0	0	0	0	0	0
22	1499511	100	100	100	100	100	Y	1	26.31	N	-	14.6	0	0	0	0	0	0
23	1503588	100	100	100	100	100	Y	1	21.53	N	-	31.3	0	0	0	0	0	0
24	1494883	100	100	100	100	100	N	0	18.75	N	-	6.15	0	0	0	0	0	0
25	1511541	100	100	100	100	100	Y	1	34.19	N	-	14.5	0	0	0	0	0	0
26	1509236	99	100	100	100	100	N	0	17.2	N	-	10.11	0	0	0	0	0	0
27	481168	100	100	100	100	100	N	0	10.34	N	-	12	0	0	0	0	0	0
28	1280648	100	100	100	100	100	N	0	17.95	N	-	12.86	0	0	0	0	0	0
29	1351130	100	100	100	100	100	N	0	16.6	N	-	21.8	0	0	0	0	0	0
30	1520272	100	100	100	100	100	N	0	17.9	N	-	15	0	0	0	0	0	0
31	1510521	100	100	100	100	100	Y	3	40	N	-	31	0	0	0	0	0	0
32	1521698	100	100	100	100	100	Y	2	27.67	N	-	8.82	0	0	0	0	0	0
33	1515665	100	100	100	100	100	Y	1	35.11	N	-	10.71	0	0	0	0	0	0
34	1503133	100	100	100	100	100	N	0	14.81	N	-	22.5	0	0	0	0	0	0
35	1531681	100	100	100	100	100	Y	1	23.56	N	-	20.51	0	0	0	0	0	0
36	1531195	100	100	100	100	100	N	0	18.85	N	-	15.06	0	0	0	0	0	0
37	1210983	100	100	100	100	100	N	0	15.78	N	-	11.68	0	0	0	0	0	0
38	1600213	100	100	100	100	100	Y	1	23.88	N	-	17.2	0	0	0	0	0	0
39	1600231	100	100	100	100	100	N	0	15.94	N	-	16.6	0	0	0	0	0	0
40	1605026	99	100	100	100	100	N	0	16.9	N	-	15.5	0	0	0	0	0	0
41	1607829	99	99	100	100	100	N	0	16.9	N	-	19.5	0	0	0	0	0	0
42	1608300	99	99	100	100	100	Y	1	28.36	N	-	18.18	0	0	0	0	0	0
43	1042399	100	100	100	100	100	Y	2	29.4	N	-	17.3	0	0	0	0	0	1
44	1612430	99	100	100	100	100	N	0	18.43	N	-	12.5	0	0	0	0	0	0
45	1613711	99	99	99	100	100	N	0	13.6	N	-	14.2	0	0	0	0	0	0
46	1625493	100	98	100	100	100	N	0	9.67	N	-	14.28	0	0	0	0	0	0
47	1631127	100	100	100	100	100	N	0	15.32	N	-	13.95	0	0	0	0	0	0
48	1631993	100	100	99	100	100	Y	1	25	N	-	26.43	0	0	0	0	0	0
49	1578062	100	100	100	100	100	Y	2	33.12	N	-	13.87	0	0	0	0	0	0
50	1553806	99	100	100	99	99	N	0	13.6	N	-	8.33	0	0	0	0	0	0
51	1631117	100	100	100	100	100	N	0	16.55	N	-	5.15	0	0	0	0	0	0
52	389832	98	98	98	97	99	N	0	11.26	N	-	6.41	0	0	0	0	0	0
53	1524866	100	100	100	100	100	N	0	10.4	N	-	11.68	0	0	0	0	0	0
55	117065	100	100	100	100	100	N	0	15.78	N	-	10.8	0	0	0	0	0	0
56	1638622	99	100	100	99	99	N	0	12.8	N	-	12.9	0	0	0	0	0	0

Sr. No	MRD. No	COMPLICATION_ 12 Minute	COMPLICATION_ 14 Minute	COMPLICATION_ 16 Minute	COMPLICATION_ 18 Minute	COMPLICATION_ 20 Minute	COMPLICATION_ 22 Minute	COMPLICATION_ 24 Minute	COMPLICATION_ 26 Minute	COMPLICATION_ 28 Minute	COMPLICATION_ 30 Minute	COMPLICATION_ 40 Minute	COMPLICATION_ 50 Minute	COMPLICATION_ 60 Minute	EPHEDRINE 6 MG	EPHEDRINE TIME
1	1370328	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
2	1414992	1	0	0	0	0	0	0	0	0	0	0	0	0	1	12
3	1415929	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
4	1400076	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
5	1423427	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
6	1414111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
7	1419866	0	0	1	0	0	0	0	0	0	0	0	0	0	1	16
8	1433760	0	0	0	0	0	0	1	0	0	0	0	0	0	2	14,24
9	1423874	0	0	0	0	0	0	1	0	0	0	0	0	0	1	24
10	1400342	0	0	0	0	0	0	0	1	0	0	0	0	0	1	26
11	1438312	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
12	1251486	0	0	1	0	0	0	0	0	0	0	0	0	0	1	8
13	1435992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
14	524105	0	0	1	0	0	0	1	0	0	0	0	0	0	1	24
15	1473518	0	1	0	0	0	0	0	0	0	0	0	0	0	1	14
16	1336883	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
18	1476910	0	0	0	1	0	0	0	0	0	0	0	0	0	1	10
20	40180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
21	1491256	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
22	1499511	0	0	1	0	0	0	0	0	0	0	0	0	0	0	-
23	1503588	1	0	0	0	0	0	0	0	0	0	0	0	0	0	-
24	1494883	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
25	1511541	0	0	0	0	0	0	1	0	0	0	0	0	0	0	-
26	1509236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
27	481168	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
28	1280648	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
29	1351130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
30	1520272	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
31	1510521	0	1	0	1	0	0	0	1	0	0	0	0	0	1	26
32	1521698	0	0	1	0	0	0	1	0	0	0	0	0	0	1	24
33	1515665	0	1	0	0	0	0	0	0	0	0	0	0	0	0	-
34	1503133	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
35	1531681	0	0	1	0	0	0	0	0	0	0	0	0	0	0	-
36	1531195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
37	1210983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
38	1600213	1	0	0	0	0	0	0	0	0	0	0	0	0	0	-
39	1600231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
40	1605026	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
41	1607829	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
42	1608300	0	0	1	0	0	0	0	0	0	0	0	0	0	1	16
43	1042399	0	0	1	0	0	0	0	0	0	0	0	0	0	1	12
44	1612430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
45	1613711	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
46	1625493	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
47	1631127	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
48	1631993	0	1	0	0	0	0	0	0	0	0	0	0	0	0	-
49	1578062	1	0	0	1	0	0	0	0	0	0	0	0	0	1	18
50	1553806	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
51	1631117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
52	389832	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
53	1524866	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
55	117065	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
56	1638622	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-

Sr. No	MRD. No	FLUID BOLUS	FLUID BOLUS TIME	INTERVENTION_0 Minute	INTERVENTION_2 Minute	INTERVENTION_4 Minute	INTERVENTION_6 Minute	INTERVENTION_ 8 Minute	INTERVENTION_ 10 Minute	INTERVENTION_ 12 Minute	INTERVENTION_ 14 Minute	INTERVENTION_ 16 Minute
1	1370328	0	-	-	-	-	-	-	-	-	-	-
2	1414992	0	-	-	-	-	-	-	-	EPHEDRINE 6 MG	-	-
3	1415929	0	-	-	-	-	-	-	-	-	-	-
4	1400076	0	-	-	-	-	-	-	-	-	-	-
5	1423427	0	-	-	-	-	-	-	-	-	-	-
6	1414111	0	-	-	-	-	-	-	-	-	-	-
7	1419866	1	10	-	-	-	-	-	FLUID BOLUS	-	-	EPHEDRINE 6 MG
8	1433760	0	-	-	-	-	-	-	-	-	EPHEDRINE 6 MG	-
9	1423874	1	10	-	-	-	-	-	FLUID BOLUS	-	-	-
10	1400342	0	-	-	-	-	-	-	-	-	-	-
11	1438312	0	-	-	-	-	-	-	-	-	-	-
12	1251486	1	16	-	-	-	-	EPHEDRINE 6 MG	-	-	-	FLUID BOLUS
13	1435992	0	-	-	-	-	-	-	-	-	-	-
14	524105	1	16	-	-	-	-	-	-	-	-	FLUID BOLUS
15	1473518	0	-	-	-	-	-	-	-	-	EPHEDRINE 6 MG	-
16	1336883	0	-	-	-	-	-	-	-	-	-	-
18	1476910	1	18	-	-	-	-	-	EPHEDRINE 6MG	-	-	-
20	40180	0	-	-	-	-	-	-	-	-	-	-
21	1491256	0	-	-	-	-	-	-	-	-	-	-
22	1499511	1	16	-	-	-	-	-	-	-	-	FLUID BOLUS
23	1503588	1	12	-	-	-	-	-	-	FLUID BOLUS	-	-
24	1494883	0	-	-	-	-	-	-	-	-	-	-
25	1511541	1	24	-	-	-	-	-	-	-	-	-
26	1509236	0	-	-	-	-	-	-	-	-	-	-
27	481168	0	-	-	-	-	-	-	-	-	-	-
28	1280648	0	-	-	-	-	-	-	-	-	-	-
29	1351130	0	-	-	-	-	-	-	-	-	-	-
30	1520272	0	-	-	-	-	-	-	-	-	-	-
31	1510521	1	16	-	-	-	-	-	-	-	-	FLUID BOLUS
32	1521698	1	16	-	-	-	-	-	-	-	-	FLUID BOLUS
33	1515665	1	14	-	-	-	-	-	-	-	FLUID BOLUS	-
34	1503133	0	-	-	-	-	-	-	-	-	-	-
35	1531681	1	16	-	-	-	-	-	-	-	-	FLUID BOLUS
36	1531195	0	-	-	-	-	-	-	-	-	-	-
37	1210983	0	-	-	-	-	-	-	-	-	-	-
38	1600213	1	14	-	-	-	-	-	-	-	FLUID BOLUS	-
39	1600231	0	-	-	-	-	-	-	-	-	-	-
40	1605026	0	-	-	-	-	-	-	-	-	-	-
41	1607829	0	-	-	-	-	-	-	-	-	-	-
42	1608300	0	-	-	-	-	-	-	-	-	-	EPHEDRINE 6 MG
43	1042399	1	18	-	-	-	-	-	-	EPHEDRINE 6 MG	-	-
44	1612430	0	-	-	-	-	-	-	-	-	-	-
45	1613711	0	-	-	-	-	-	-	-	-	-	-
46	1625493	0	-	-	-	-	-	-	-	-	-	-
47	1631127	0	-	-	-	-	-	-	-	-	-	-
48	1631993	1	14	-	-	-	-	-	-	-	FLUID BOLUS	-
49	1578062	1	12	-	-	-	-	-	-	FLUID BOLUS	-	-
50	1553806	0	-	-	-	-	-	-	-	-	-	-
51	1631117	0	-	-	-	-	-	-	-	-	-	-
52	389832	0	-	-	-	-	-	-	-	-	-	-
53	1524866	0	-	-	-	-	-	-	-	-	-	-
55	117065	0	-	-	-	-	-	-	-	-	-	-
56	1638622	0	-	-	-	-	-	-	-	-	-	-

Sr. No	MRD. No	INTERVENTION_ 18 Minute	INTERVENTION_ 20 Minute	INTERVENTION_ 22 Minute	INTERVENTION_ 24 Minute	INTERVENTION_ 26 Minute	INTERVENTION_ 28 Minute	INTERVENTION_ 30 Minute	INTERVENTION_ 40 Minute	INTERVENTION_ 50 Minute	INTERVENTION_ 60 Minute
1	1370328	-	-	-	-	-	-	-	-	-	-
2	1414992	-	-	-	-	-	-	-	-	-	-
3	1415929	-	-	-	-	-	-	-	-	-	-
4	1400076	-	-	-	-	-	-	-	-	-	-
5	1423427	-	-	-	-	-	-	-	-	-	-
6	1414111	-	-	-	-	-	-	-	-	-	-
7	1419866	-	-	-	-	-	-	-	-	-	-
8	1433760	-	-	-	EPHEDRINE 6 MG	-	-	-	-	-	-
9	1423874	-	-	-	EPHEDRINE 6 MG	-	-	-	-	-	-
10	1400342	-	-	-	-	EPHEDRINE 6 MG	-	-	-	-	-
11	1438312	-	-	-	-	-	-	-	-	-	-
12	1251486	-	-	-	-	-	-	-	-	-	-
13	1435992	-	-	-	-	-	-	-	-	-	-
14	524105	-	-	-	EPHEDRINE 6 MG	-	-	-	-	-	-
15	1473518	-	-	-	-	-	-	-	-	-	-
16	1336883	-	-	-	-	-	-	-	-	-	-
18	1476910	FLUID BOLUS	-	-	-	-	-	-	-	-	-
20	40180	-	-	-	-	-	-	-	-	-	-
21	1491256	-	-	-	-	-	-	-	-	-	-
22	1499511	-	-	-	-	-	-	-	-	-	-
23	1503588	-	-	-	-	-	-	-	-	-	-
24	1494883	-	-	-	-	-	-	-	-	-	-
25	1511541	-	-	-	FLUID BOLUS	-	-	-	-	-	-
26	1509236	-	-	-	-	-	-	-	-	-	-
27	481168	-	-	-	-	-	-	-	-	-	-
28	1280648	-	-	-	-	-	-	-	-	-	-
29	1351130	-	-	-	-	-	-	-	-	-	-
30	1520272	-	-	-	-	-	-	-	-	-	-
31	1510521	-	-	-	-	EPHEDRINE 6 MG	-	-	-	-	-
32	1521698	-	-	-	EPHEDRINE 6 MG	-	-	-	-	-	-
33	1515665	-	-	-	-	-	-	-	-	-	-
34	1503133	-	-	-	-	-	-	-	-	-	-
35	1531681	-	-	-	-	-	-	-	-	-	-
36	1531195	-	-	-	-	-	-	-	-	-	-
37	1210983	-	-	-	-	-	-	-	-	-	-
38	1600213	-	-	-	-	-	-	-	-	-	-
39	1600231	-	-	-	-	-	-	-	-	-	-
40	1605026	-	-	-	-	-	-	-	-	-	-
41	1607829	-	-	-	-	-	-	-	-	-	-
42	1608300	-	-	-	-	-	-	-	-	-	-
43	1042399	FLUID BOLUS	-	-	-	-	-	-	-	-	-
44	1612430	-	-	-	-	-	-	-	-	-	-
45	1613711	-	-	-	-	-	-	-	-	-	-
46	1625493	-	-	-	-	-	-	-	-	-	-
47	1631127	-	-	-	-	-	-	-	-	-	-
48	1631993	-	-	-	-	-	-	-	-	-	-
49	1578062	EPHEDRINE 6 MG	-	-	-	-	-	-	-	-	-
50	1553806	-	-	-	-	-	-	-	-	-	-
51	1631117	-	-	-	-	-	-	-	-	-	-
52	389832	-	-	-	-	-	-	-	-	-	-
53	1524866	-	-	-	-	-	-	-	-	-	-
55	117065	-	-	-	-	-	-	-	-	-	-
56	1638622	-	-	-	-	-	-	-	-	-	-

Baba Farid University
of Health Sciences
Sadiq Road
Faridkot-151 203 (Pb). INDIA.
Phone : 01639-256232,256236
Tele/Fax : 01639-256235
Email – Thesisbfuhs@gmail.com

(8)

No. BFUHS/2K23p-TH/ 13149 Date 27/12/23

The Principal
Dayanand Medical College & Hospital
Ludhiana

Subject:: Approval of Plan of Thesis.

This is to inform you that the Faculty of Medical Sciences in its meeting held on 25.09.2023 has approved the plan of thesis of **Parth Arora**, a student of your college for **MD Anaesthesiology** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
To study the predicitive value of internal jugular vein collapsibility index and common carotid artery peak systolic velocity variation in prediction of post spinal hypotension .

Supervisor
Dr. Suneet Kant Kathuria
Professor
Dept. of Anaesthesiology,

Co-Supervisor:-
Dr. Richa Jain
Assoc. Professor
Dept. of Anaesthesiology,

The student may submit the thesis in triplicate alongwith the plan in triplicate also, to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She may be directed to attach a photocopy of this letter with the forwarding letter while submitting thesis in the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic, if any.

Controller of Examinations

Note :

1. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*

TO STUDY THE PREDICITIVE VALUE OF INTERNAL JUGULAR VEIN COLLAPSIBILITY INDEX AND COMMON CAROTID ARTERY PEAK SYSTOLIC VELOCITY VARIATION IN PREDICTION OF POST SPINAL HYPOTENSION

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED IN

PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MD

In

ANAESTHESIOLOGY

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

AUGUST, 2022

DR. PARTH ARORA

DEPARTMENT OF ANAESTHESIOLOGY
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	TO STUDY THE PREDICITIVE VALUE OF INTERNAL JUGULAR VEIN COLLAPSIBILITY INDEX AND COMMON CAROTID ARTERY PEAK SYSTOLIC VELOCITY VARIATION IN PREDICTION OF POST SPINAL HYPOTENSION
For the degree of	MD Anaesthesia
Name of the candidate	Dr. Parth Arora
Supervisor	Dr. Suneet Kant Kathuria, Professor, Department Of Anaesthesiology, DMCH, Ludhiana
Co-Supervisor	Dr. Richa Jain, Associate Professor, Department Of Anaesthesiology, DMCH, Ludhiana
Institution	Dayanand Medical College and Hospital,Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Hypotension after spinal anaesthesia is one of the commonest complications that occur due to sympatholysis. Intraopertive arterial hypotension has been linked to an increase in patient morbidity and mortality. In few studies the Internal Jugular Vein Collapsibility Index and Common Carotid Artery Peak Systolic Variations have shown to help in prediction of hypotension after spinal anaesthesia.

Aim of Study: To study and compare the predictive value of internal jugular vein collapsibility index and common carotid peak systolic velocity variation in prognostication of hypotension after spinal anaesthesia.

Materials & methods: A prospective observational study will be conducted on 50 adult patients of ASA I, II and III scheduled to undergo elective surgery under spinal anaesthesia after taking a written informed consent. The Internal Jugular Vein Collapsibility index and Common Carotid Artery Peak Systolic Velocity Variation will be used as methods for prediction of post spinal hypotension. After giving spinal anaesthesia using a standard protocol, monitoring of heart rate, systolic, diastolic and mean blood pressure will be done upto 30 minutes to compare incidence and severity of hypotension.

Clinical Significance: Early prediction of hypotension after spinal anaesthesia will help in early institution of measures to prevent the incidence and severity of hypotension hence reducing perioperative morbidity and mortality.

Keywords: Common Carotid Artery, Peak Systolic Velocity, Internal Jugular Vein Collapsibility Index, Spinal Anaesthesia, Hypotension, Post Spinal Hypotension

(Signature) Candidate	(Signature) Co-supervisor	(Signature) Supervisor	(Signature) Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"TO STUDY THE PREDICITIVE VALUE OF INTERNAL JUGULAR VEIN COLLAPSIBILITY INDEX AND COMMON CAROTID ARTERY PEAK SYSTOLIC VELOCITY VARIATION IN PREDICTION OF POST SPINAL HYPOTENSION"** exist in the Department of Anaesthesia at Dayanand Medical College and Hospital, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate himself under our supervision and guidance.

Supervisor

Dr. Suneet Kant Kathuria
Professor,
Department of Anaesthesia,
DMCH, Ludhiana

Co-Supervisor

Dr. Richa Jain
Associate Professor,
Department of Anaesthesia ,
DMCH, Ludhiana

Head of the Department

Dr. Anju Grewal
Professor & Head
Department of Anaesthesia
DMCH, Ludhiana

Place : LUDHIANA

Date : 10/09/22

APPROVAL PROFORMA
BY
RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	Dr. ParthArora
Department	Anaesthesia
Topic of Thesis	TO STUDY THE PREDICITIVE VALUE OF INTERNAL JUGULAR VEIN COLLAPSIBILITY INDEX AND COMMON CAROTID ARTERY PEAK SYSTOLIC VELOCITY VARIATION IN PREDICTION OF POST SPINAL HYPOTENSION
Likely date of appearing in PG examination	May/ June, 2024
Date of enrollment	March 7, 2022
Name of Head of Department	Dr Anju Grewal
1) Supervisor **2) Co-Supervisor**	Dr. Suneet Kant Kathuria Dr. Richa Jain
Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
Dr. Harpreet Kaur (Professor & Head, Pathology)	Mr. R K Sharma (Legal Expert)
Dr. Jaspal Singh (Professor & Head, Surgery)	Dr. Ramit Mahajan (Associate Professor, Gastroenterology)
Dr. Dinesh Gupta (Professor & Head, Medicine)	Dr. Anu Sharma (Professor, Anatomy)
Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)	Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)
Dr. Gurpreet S Wander (Vice Principal)	Dr. Gurpreet S Wander (Vice Principal & Professor & Head, Cardiology)
	Dr. Gagandeep Singh (Secretary, Ethics Committee Professor & Head, Neurology)

Approved: Yes / ~~No~~

Dr. Sandeep Puri
Chairperson
Research Committee

Chairperson
Research Committee

Approved: Yes / ~~No~~

Prof. Arvind Malhotra
Chairperson
Ethics Committee

Chairperson
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

1.	NAME OF THE CANDIDATE AND ADDRESS	DR. PARTH ARORA JALALABAD (W) DISTT FAZILKA PUNJAB
2.	NAME OF THE INSTITUTE	Dayanand Medical College and Hospital, Ludhiana
3.	COURSE OF STUDY AND SUBJECT	M.D. Anaesthesiology
4.	DATE OF ADMISSION OF COURSE	7th March,2022
5.	TITLE OF THE TOPIC	TO STUDY THE PREDICITIVE VALUE OF INTERNAL JUGULAR VEIN COLLAPSIBILITY INDEX AND COMMON CAROTID ARTERY PEAK SYSTOLIC VELOCITY VARIATION IN PREDICTION OF POST SPINAL HYPOTENSION

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Spinal anaesthesia is a safe and reliable method frequently used in various lower abdominal, orthopedic, and obstetric operations. It has advantages such as the rapid onset of action, cost-effectiveness, ease of administration, and relatively fewer side effects.

Post spinal anaesthesia can be associated with nausea, vomiting, syncope, dizziness, aspiration, cardiac arrhythmias, cardiac arrest, and sometimes even mortality.[1] Hypotension and bradycardia are the most common side effects of spinal anaesthesia. Hypotension post spinal anaesthesia is one of the most common and serious side effects. Hypotension occurs due to decrease in systemic vascular resistance (SVR) because of sympatholysis and decrease in cardiac output (CO) because of reduced venous return.[2] Intraoperative hypotension has been found to correlate with post‑operative outcome; hence early prediction of post spinal hypotension is crucial to a successful outcome, as timely interventions may prevent any untoward event.

Till date, many beneficial modalities such as prophylactic intravenous fluid and vasopressors administration have been proposed to prevent postspinal hypotension. However, most of those have limited effectiveness, and are associated with several dangerous consequences especially in patients with hypovolemia, underlying cardiac and pulmonary diseases. Hence, accurate measurement of intravenous fluid volume status before giving spinal anaesthesia is of esteemed importance.[3]

Various invasive and non invasive methods have been employed to predict post spinal hypotension in patients like central venous pressure monitoring (CVP), jugular venous pressure monitoring , inferior vena cava collapsibility index (IVCCI), transthoracic echocardiography (TTE), transthoracic bioimpedance, passive leg raising test (PLRT) etc.[4,5]

Methods like transthoracic echocardiography and bio-impedance are time consuming and expensive. Similarly CVP monitoring is also an invasive and time consuming intervention. Non invasive methods using ultrasound like internal jugular vein collapsibility index (IJVCI) and carotid artery peak systolic flow velocity variation (CAPVV) are easy to perform, less time consuming and are readily available. The IVCCI, IJVCI and CAPVV are most commonly used parameters for assessing the volume status of critically ill patients and have been individually investigated as predictors of post spinal hypotension and hypotension after induction of general anaesthesia.[2,5]

IVCCI measurements are some times not possible in about 10%-15% of patients because of large body size, excessive gas in bowel, or large amounts of intra-thoracic air.[6] It is well known that pressure and volume changes within the intrathoracic systemic venous compartment are reflected by the extrathoracic veins, such as in the internal jugular vein (IJV). Ultrasonography of IJV diameter has also been studied in numerous studies to evaluate hypovolemia after blood donation. Recently, Guarracino et al.[7] showed that IJV distensibility accurately predicts responsiveness to fluid and found out that IJV distensibility more than 18% after volume challenge had 80% sensitivity and 85% specificity in predicting the response.

Studies have reported that IJV ultrasound study can estimate the intravascular volume or fluid responsiveness In patients of shock, the passive leg raising (PLR) test has been useful in assessment of fluid responsiveness .Similar to PLR, change in the IJV size with change in posture from the supine to trendelenburg position might reveal intravascular volume status.

Ultra-sonographic carotid artery measurements help in prediction of peak blood flow velocity, which further helps in prediction of post spinal anaesthesia hypotension. In a study, the predictive power for fluid responsiveness of respirophasic variation of carotid artery peak systolic

velocity was greater than that of pulse pressure variation (PPV). Therefore, although it is a dynamic index, it can be used to adequately evaluate volume status in spontaneously breathing patients.[8]

A number of studies have shown good co-relation between IVC collapsibility index and CVP measurements in assessment of volume status of patient and for prediction of post spinal anaesthesia hypotension.[9,10] A positive relation has been reported in between IVC Collapsibility Index and IJV Collapsibility Index in prediction of post spinal hypotension in few studies.[11,12] Ultrasonographic common carotid artery peak systolic variations has also been shown to have good results in prediction of hypotension and fluid responsiveness post spinal anaesthesia. Till date no study has been done to compare IJV collapsibility index and common carotid artery peak systolic variation for predicting post spinal anaesthesia hypotension, hence we aim to compare both and find out which parameter out of above two is better for predicting hypotension after spinal anaesthesia.

6.2 REVIEW OF LITERATURE

Hypotension post spinal anaesthesia is common, and is one of the important cause of concern for anesthesiologists, especially in high-risky patients such as the elderlies and those with underlying organ dysfunction. Hypotension occurs due to decrease in systemic vascular resistance (SVR) because of sympatholysis and decrease in cardiac output (CO) due to increased pooling of blood in lower body, leading to low preload and low cardiac output. Many studies and efforts have been made to lower the incidences of hypotension.

The study by **Bano S et al**.[4] showed that ultrasonographicIJV/CCA ratio could be an alternative and noninvasive tool of central venous catheterization in evauation of hemodynamic status of critically ill patients, in prediction of hypotension.

Zhang and Critchley[13] suggested that measuring IVCCI pre-operative ultrasonographically had a good predictive value for hypotension after induction of general anaesthesia, with a sensitivity of 78.6% and a specificity of 91.7% at a cut-off value of 43%.**Hossein et al**.[14] investigated the accuracy of the IJV/CCA CSA ratio in prediction of CVP in 52 critically ill adult patients. A significant correlation was found between the IJV/CCA CSA ratio and the CVP; while the highest sensitivity was 90% the specificity was 86.36% for a CVP of < 10 cmH2O.

In the study by **Singh et al**[15], they examined the relationship between sonographicIVC measurements and postspinal hypotension, and found no positive correlation. Although it was conducted only on young pregnant patients, who underwent cesarean section, can be considered as an important limitation for the statistical results. Contrary to that study**,** **Salama et al**[16], found in their study that IVC collapsibility index and IVC aorta index were reliable predictors for the occurrence of postspinal anesthesia hypotension.

In a study by **Guarracino et al**[7] in critically ill ventilator-dependent septic patients, they found changes of IJV distensibility in septic patients with mandatory ventilation was highly predictive of a response to fluid administration. The combined use of IJV distensibility and pulse pressure variations increases the predictive value of fluid responsiveness.

Collapsibility index of IJV, was found to be a predictor of postspinal hypotension in the study by **Kılıç Yet al**[6], even though sensitivity and specifity rates were moderate. Nowadays, IJV collapsibility index and other sonographic parameters are being increasingly used as an alternative to IVC in the measurement of central venous pressure. Compared to IVC imaging, ultrasonographic evaluation of IJV is easier and time-saving. Furthermore, IVC imaging cannot be possible in patients of obesity and having abdominal gas shadow. Additionally, anesthesiologists are more familiar to IJV anatomy as they frequently perform ultrasound-guided central IJV catheterization in their routine practice.

Killu and team[9] analysed that IJV diameter collapsibility index of > 39% can be associated with hypovolemia. According to statistical analysis, the area under the curve for their study was similar to area under the curve using central venous pressure for hypovolemia.

Inferior vena cava ultrasonography usage has been limited by other drawbacks, such as the variety of methods used, lack of evidence-based cut-offs, and technical difficulties in performing ultrasound of obese patients. In comparison, **Lance Beier et al**[17] found that the carotid artery is easily assessable with ultrasound, and CAPVV of the carotid artery is predictive of fluid responsiveness in spontaneously breathing patients.

Study by **Y.Song et al**[8] indicate, the predictability of CAPVV was superior to that of pulse pressure variation (PPV) with also CAPVV resulted a cut-off value with the highest sensitivity and specificity. CAPVV was the only variable that showed no significant changes in non-responders after the fluid challenge, showing that it has a strong

association with preload, while PPV showed a significant decrease after fluid challenge even in non-responders. Aside from being non-invasive and practical, there is a role for CAPVV as a predictor of fluid responsiveness in certain clinical situations when arterial cannulation is not easily feasible or radial artery PPV would not give genuine results.

Study by **Samaa A Kasem et al**[12] in 35 intensive care unit patients post major surgery stated IJV/CCA cross-sectional area measurement is also one of the non invasive method which correspond to volume status of the patient. The cross-sectional area of IJV and CCA are measured using ultrasound and their values are compared with CVP before and after fluid loading.

Jassim HM et al[10] demonstrated in their study a significant correlation between IJV collapsibility index using parameters of diameter and cross sectional area at 0°, as well as at 30° positions with invasively monitored CVP. The result showing the measurement at 30° showing more significant correlation than that at 0°. Hence can be used as a first-line approach for the bedside non-invasive assessment of CVP/fluid status in critical patients.

Ting-ting Ni et al[5] analysed that the development of hypotension after spinal anesthesia might be related to increased IVC collapsibility. IVCCI measurement using ultrasound was a reliable predictor of hypotension after induction of spinal anesthesia, at a cut off point of >42%. Fluid management using IVCCI predictability helps in reducing the incidence of post spinal anaesthesia hypotension.

Broilo et al. [18] analyzed respiratory variations in IVC diameter in 39 ventilated patients with hemodynamic instability. They showed that respiratory variation in IVC is a marker for evaluation of fluid responsiveness, and demonstrated the correlation between respiratory variation of IVC diameter and that of IJV diameter

Achar S K et al[19] Respiratory variation in aortic flow peak velocity and inferior vena cava distensibility index are reliable indices of fluid responsiveness in children

Frolich et al[20] found a significant co-relation with baseline heart rate and sympathetic tone of the patient. They found the role of baseline heart rate in prediction of post spinal anaesthesia hypotension in obstetrics patients. The study revealed patients with higher baseline heart rate had higher sympathetic tone and had greater risk of fall in blood pressure post spinal anaesthesia due to sympatholysis.

In above mentioned studies we have found non invasive measurements to be useful in prediction of hypotension post spinal anaesthesia, so we plan to compare two different indices of ijv collapsibility index and cca peak flow velocity in prediction of hypotension.

6.3 AIMS AND OBJECTIVES OF THE STUDY

To study the predicitive value of internal jugular vein collapsibility index and common carotid artery peak systolic velocity variation in prediction of post spinal hypotension.

7. MATERIAL AND METHODS

7.1 SOURCE OF DATA

This prospective, observational study will be conducted in the Department of Anaesthesiology, Dayanand Medical College & Hospital, Ludhiana after approval by Institutional Ethics Committee on a total of 50 adult ASA physical status I, II and III patients of either sex, undergoing surgery under spinal anaesthesia. To compensate for case dropout because of failed spinal or inadequate / partial effect of spinal anaesthesia 5 additional cases will also be enrolled making it to a total of 55 cases. A written informed consent will be obtained from all the patients.

7.2 Methods of Collection of Data

Inclusion Criteria

Patients Age > 18 Years

Patients posted for elective surgery under spinal anaesthesia

ASA I, II & III patients

Exclusion Criteria

Refusal of Consent for study by the patient

Presence of any wound/dressing/swelling/structural abnormality in neck

Infection at the site of spinal injection

Thrombocytopenia and coagulopathies and patients on current anti-coagulant/anti-platelet therapy

Pregnant females

Pre-existing severe cardiac, renal or liver disease

PRE ANAESTHETIC CHECKUP

A complete pre anaesthetic check-up will be done which will include a detailed history including allergy to any drug, pre-existing co-morbidities and medication history, general, physical and systemic examination and relevant laboratory investigations as per patient physical status and institutional protocol. The demographic details including age, sex, height, weight and BMI etc. will be recorded. Patient will be explained about the study protocol and a written informed consent will be obtained.

METHODOLOGY

After shifting the patient to operating room, patient will be positioned in supine position. After sign in proceedings as per WHO protocol, standard monitoring will be started using non invasive blood pressure (NIBP), pulse oximetery and 5 lead electrocardiography. The baseline values of heart rate, NIBP, oxygen saturation, pulse rate will be recorded after taking a mean of two successive readings at 2 minutes apart.

For IJV collapsibility index measurement, patient will be positioned in supine position with 30° head elevation of operating table and the observer will stand on the head end of the patient with his neck turned to the left side. An ultrasound 6 -13 MHz linear probe will be placed horizontally to the right side of the middle of the thyroid cartilage to obtain a clear, circular cross-sectional image of the right IJV by rotating the transducer clockwise or counter-clockwise with minimal pressure on IJV. Using M-mode of ultrasound, maximum and minimum Antero-Posterior (AP) diameters of IJV will be assessed. The IJV Collapsibility Index is derived by the formula:

IJV Collapsibility Index (IJV CI) =

(Maximum AP diameter - Minimum AP diameter)/ Max AP diameter X 100

For carotid artery peak systolic velocity measurements, patient will be kept in supine position with his / her neck turned to the left side and the observer stands on the head end of the patient. The right CCAPSV measurements will be obtained at 2 cm proximal from the carotid bifurcation to avoid overlap with extension of bulb lesions. In long axis, B-mode wave doppler will be used after placing the sample volume at the centre of the arterial lumen. Waveforms of CCA will be obtained with a 6-13MHz linear transducer at 60° insonation angle. The maximum peak systolic velocity (PV max) and minimum (PV min) peak systolic velocities will be measured from the spectral doppler tracing with a sweep speed of 50 mm/s. Carotid artery peak systolic velocity variation is calculated as:

Carotid Artery Peak Systolic Velocity Variation(CAPVV) =

[(PV max- PV min)/PV mean] × 100

where PV mean = (PV max + PV min)/2

Two readings of IJV CI and CA PVV will be obtained and their mean values will be calculated and recorded.

An appropriate size IV cannula will be secured in a suitable peripheral vein and co-loading with crystalloid solution (10ml/kg over 15 minutes) will be initiated while starting with induction of spinal anaesthesia.

With patient in sitting position, back of the patient will be cleaned and draped using povidine iodine 10% w/v and spinal block will be performed using 26 G Quincke needle in L -3 and L-4 inter spinal space. After confirmation of a free flow of CSF, 12.5mg Bupivacaine Heavy 0.5% (2.5ml) with 25 µg Fentanyl (0.5 ml) as an adjuvant, will be injected in sub arachnoid space.

Patient will be shifted to supine position immediately on a flat operating table. Patient's heart rate, non invasive blood pressure and oxygen saturation will be monitored and recorded immediately post spinal anaesthesia (zero minute) and then after every 2 minutes for first 30 minutes, as per standard protocol by the attending anaesthesiologist. Sensory block will be assessed every 5 minutes by loss of pinprick sensation and motor block will be assessed very 5 minutes using Modified Bromage Scale (MBS) till 30 minutes. The highest level / degree of sensory and motor block achieved will be recorded.

Modified Bromage Scale

0= free movement of legs and feet

1= unable to raise the extended legs but able to flex knees with free movement of feet

2= unable to flex knees but with the free movement of feet

3= unable to move legs and feet

Post spinal hypotension will be defined as a reduction of the systolic blood pressure more than or equal to 20% of the baseline value after spinal

anaesthesia. The post spinal hypotension will be treated with rapid iv fluid administration and intermittent boluses of ephedrine 6mg as per need. Bradycardia will be defined as heart rate going below 60 beats per minute and will be treated with IV administration of 0.6mg atropine. Oxygen supplementation will be given if the saturation falls down <94% or patient develops significant bradycardia or hypotension.

PRIMARY OUTCOME:

To study the predicitive value of internal jugular vein collapsibility index and common carotid artery peak systolic velocity variation in prediction of post spinal hypotension.

SECONDARY OUTCOME:

To compare internal jugular vein collapsibility index and common carotid artery peak systolic velocity variation for prediction of severity of hypotension.

STATISTICAL ANALYSIS

Data will be described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. To determine whether the data is normally distributed, a Kolmogorov-Smirnov test will be used. Comparison of quantitative variables between the study groups will be done using Student t-test and Mann Whitney U test for independent samples for parametric and non-parametric data respectively. For comparing categorical data, Chi square ($\chi 2$) test will be performed and fisher exact test will be used when the expected frequency is less than 5. Receiver operator characteristics (ROC) curve will be done, and criterion value will be estimated depending on the specificity and sensitivity. Area under curve (AUC) will be measured. A probability value (p value) less than 0.05 will be considered statistically significant. All statistical calculations will be done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

Study Design - Prospective Observational Study

Sample Size Calculation:

Based on the results from previous study by Chowdhury SR et al[21], CAPVV>18.33% predicted PSH with 70.6% sensitivity and 54.6% specificity and study by Kılıç Y et al[6], IJV collapsibility index had a sensitivity of 64% and a specificity of 63.6% to predict the postspinal hypotension at a cut-off point of 22.6% with area under curve (AUC) as 0.709.

Sample size calculation for this study is done by the following formula:

Sample size based on sensitivity = $Z^2 * S_N * (1-S_N)/L*p$

Sample size based on specificity = $Z^2 * S_P * (1-S_P)/L^2 * (1-p)$

Where S_N-Sensitivity, S_P- Specificity

p- Prevalence of Hypotension

L- Absolute precision desired on either side of sensitivity and specificity

Z- Standard normal deviate corresponding to the specified size of critical region

IJV collapsibility index[6]

For sensitivity of 64%, the sample size by the above formula is 48

For a specificity of 63.6%, the sample size calculation is 27

Therefore, for the present study, the higher value that is 48 cases needs to be taken.

CCA peak flow velocity variation[21]

For sensitivity of 70.6%, the sample size by the above formula is 47

For a specificity of 54.6%, the sample size calculation is 23

Therefore, for the present study, the higher value that is 48 cases has to been taken. Hence the total sample size we will take is 50.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

The study does not require any investigation or intervention other than those routinely done for every surgery

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Yes, Attached herewith

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PROFORMA

Sr.No.	Date of surgery:	MRD.No.:
Name Initials:	Age and Sex:	ASA Grade:
Weight:	Height:	BMI:
Diagnosis:	Surgery performed:	Drug Allergy:

Current anti-coagulant/anti-platelet therapy: Yes / No

If yes date of last dose: _____

H/O severe cardiac disease: Yes / No

H/O severe renal disease: Yes / No

H/O severe liver disease: Yes / No

Investigation	**Lab Values**
Hemoglobin (g/dl)	
TLC (10^3/ µl)	
Platelet count(10^3/µl)	
Prothrombin Time (sec) / International Normalized Ratio	
S Bilirubin (mg/dl)	
SGOT (U/L)	
SGPT (U/L)	
ALP (U/L)	
S Albumin (g/dl)	
B Urea (mg/dl)	
S Creatinine (mg/dl)	
Sodium /Potassium / Chloride (mEq/L)	
ECG	

Signature of Candidate **Signature of Supervisor**

Baseline Vital Parameters:

	Reading 1	Reading 2	Mean
Systolic BP (mm HG)			
Diastolic BP (mm HG)			
Mean BP (mm HG)			
Heart Rate (beats/min)			
SpO_2 (%)			

CA PVV Parameters:

	Reading 1	Reading 2	Mean
Maximum Peak Velocity: (cm/sec)			
Minimum Peak Velocity: (cm/sec)			
Mean Peak Velocity: (cm/sec)			
Peak Velocity Variation: (%)			

IJV Parameters:

	Reading 1	Reading 2	Mean
Maximum diameter: (mm)			
Minimum diameter: (mm)			
IJV collapsibility index: (%)			

SUBARACHANOID BLOCK CHARACTERISTICS:

	Level of Sensory Block	Level of Motor Block
0 Minute		
5 Minute		
10 Minute		
15 Minute		
20 Minute		
25 Minute		
30 Minute		

Highest level of sensory block achieved:

Highest degree of motor block achieved:

Signature of Candidate **Signature of Supervisor**

Time (Minutes)	Heart Rate (bpm)	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)	Mean Blood Pressure (mmHg)	Oxygen Saturation (SpO_2)	Complication	Intervention
0							
2							
4							
6							
8							
10							
12							
14							
16							
18							
20							
22							
24							
26							
28							
30							
40							
50							
60							

Hypotension Episode : Yes/No

Bradycardia Episode: Yes /No

Maximum % fall in BP:

Maximum % fall in HR:

Signature of Candidate

Signature of Supervisor III

INFORMED PATIENT CONSENT

Date: _____

I…….D/o, W/o, S/o……..…… am willing to participate in the study **"TO STUDY THE PREDICITIVE VALUE OF INTERNAL JUGULAR VEIN COLLAPSIBILITY INDEX AND COMMON CAROTID ARTERY PEAK SYSTOLIC VELOCITY VARIATION IN PREDICTION OF POST SPINAL HYPOTENSION"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

……. ……
Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____

निवासी _____

इस शोधकार्य **"TO STUDY THE PREDICITIVE VALUE OF INTERNAL JUGULAR VEIN COLLAPSIBILITY INDEX AND COMMON CAROTID ARTERY PEAK SYSTOLIC VELOCITY VARIATION IN PREDICTION OF POST SPINAL HYPOTENSION"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

“TO STUDY THE PREDICITIVE VALUE OF INTERNAL JUGULAR VEIN COLLAPSIBILITY INDEX AND COMMON CAROTID ARTERY PEAK SYSTOLIC VELOCITY VARIATION IN PREDICTION OF POST SPINAL HYPOTENSION” ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

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ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

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ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

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ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ